573

SEP 16 1924

W. B. No. 839

U. S. DEPARTMENT OF AGRICULTURE
WEATHER BUREAU

MONTHLY WEATHER REVIEW

VOLUME 52, No. 6

JUNE, 1924

WASHINGTON
GOVERNMENT PRINTING OFFICE
1924

JUNE, 1924

CONTENTS

	Page
On a simple method of recording the total and partial intensities of solar radiation. **L. Gorczyński.** (5 figs.)	299–301
Intercomparison of pyrheliometers. **H. H. Kimball**	302
Investigations relative to the polar front **J. W. Sandström**	302–303
The so-called monsoonal winds of Texas. **A. J. Henry**	304–305
The cotton plant in relation to temperature and rainfall. **J. B. Kincer.** (2 figs.)	306–307
On the probability of rain. **L. Besson.** *Transl.*	308
Summary of correlations between Hawaiian rainfall and solar phenomena. **J. B. Cox**	308
The Lorain, Ohio, tornado of June 28, 1924. **H. C. Hunter.** (3 figs.)	309–310
The southern Maryland windstorm of June 8, 1924. **B. F. Dashiell**	310–311
Record cloudburst in Carter County, Tenn., June 3, 1924. **W. R. King.** (3 figs.)	311–313
NOTES, ABSTRACTS, AND REVIEWS:	
Tropical cyclones. *Repr.*	113
Lightning explodes dynamite	113
Weather conditions in the polar regions and Amundsen's polar flight	313–314
BIBLIOGRAPHY:	
Recent additions to the Weather Bureau library	314
Recent papers bearing on meteorology and seismology	314–316
WEATHER OF THE MONTH	
SOLAR OBSERVATIONS:	
Solar and sky radiation measurements during June, 1924	316
WEATHER OF NORTH AMERICA AND ADJACENT OCEANS:†	
North Atlantic Ocean	317–318
North Pacific Ocean	318–319
Arabian Sea and South Pacific Ocean	319
DETAILS OF THE WEATHER IN THE UNITED STATES:	
General conditions	319
Cyclones and anticyclones	319
Free-air summary	319–322
The weather elements	322–323
Severe local hail and wind storms, June, 1924	324–325
Weather warnings	326–327
Rivers and floods	327–329
Effect of weather on crops and farming operations	329
TABLES:	
Climatological tables	330–334
Seismological tables	335–336
CHARTS	
I. Tracks of centers of anticyclonic areas	63
II. Tracks of centers of cyclonic areas	64
III. Departure (°F.) of mean temperature from the normal	65
IV. Total precipitation, inches	66
V. Percentage of clear sky between sunrise and sunset	67
VI. Isobars at sea level and isotherms at surface, prevailing winds	68
VII. Total snowfall, inches (not charted)	—
VIII–XI. Weather maps of North Atlantic Ocean, June 3–6	69–72

† In marine separate.

CORRECTION

REVIEW, May, 1924: Page 250, the legend under the figure in column 2 should read: "Figure 2.—Time-altitude curves for the a. m. data (lower solid curve), p. m. data (upper solid curve), and the a. m. and p. m. data combined (intermediate solid curve). The broken curve shows the assumed altitudes."

Page 251, the legend under the figure should read: "Figure 1.—Ascensional rate-altitude curves for the a. m. data, p. m. data, and a. m. and p. m. data combined."

MONTHLY WEATHER REVIEW

ALFRED J. HENRY, Editor

VOL. 52, No. 6.
W. B. No. 839.

JUNE, 1924

CLOSED AUGUST 2, 1924.
ISSUED AUGUST 30, 1924.

THE OCCURRENCE OF HAIL

EDITOR'S NOTE.—In response to the demand for more specific data on the occurrence of hail in the United States, the Weather Bureau began in the April number of this REVIEW the publication of reports on the occurrence of hailstorms as observed by its regular and cooperative observers, numbering approximately 5,200. Cooperative observers report directly to the Weather Bureau officials in charge of the several section centers and these officials in turn transmit the reports to the Central Office in Washington, D. C. The reports are incorporated in the table which hitherto has borne the title "Severe Local Storms." That table will be found on pages 324–325 of this REVIEW, and it will appear in approximately the same position hereafter.

ON A SIMPLE METHOD OF RECORDING THE TOTAL AND PARTIAL INTENSITIES OF SOLAR RADIATION

By LADISLAUS GORCZYŃSKI, D. Sc.

(Washington, June 14, 1924)

Synopsis.—A simple form of recording pyrheliometer is obtained from the combination of a thermopile of the Moll type with a recording voltmeter of the Richard type. The large-surface thermopile is composed of 80 elements made from thin strips of manganin and constantan, which are placed in a circle nearly 2 cm. in diameter. These strips can be exposed to radiation over their whole length.

The thermopile is question affords a high degree of stability (absence of zero errors) and sensitivity, together with great quickness in action, namely, the time elapsing between the admission of radiation and the moment at which the full electro-motive force is reached, is less than two seconds. The radiation from a candle at one meter distance yields about 90 microvolts.

Other details and some historical data are given.

With a recording voltmeter (Richard type) the large-surface thermopile, properly diaphragmed and equatorially mounted (clock driven), gives a new form of thermoelectric pyrheliometer, very rugged, and simple in use even for inexperienced observers. A solar radiation intensity of one gram-calory per minute per square centimeter of surface normal to the incident rays develops a current having an electromotive force of about 16 millivolts; this voltage is very nearly proportional to the intensity of the solar radiation so that the pyrheliometric records can be directly calibrated in gram-calories/cm.²/min.

An illustration of the new pyreheliometer is given, with three sample records from measurements made by the author in the Desert of Sahara. The method of obtaining the partial intensities by the use of colored glasses and liquid light filters is also indicated.

THERMOELECTRIC METHOD OF MEASURING RADIATION.

Independent of the ordinary thermometric method, the endeavors to apply the thermoelectric current to measurements of radiation date back several years. Special attention may be called to the old thermoelectric pyrheliometer constructed by Professor Crova and used at the University of Montpellier, France, in 1890. Among other forms we note especially the instrument of Féry, constructed in the beginning of the twentieth century. The difficulties met with in the application of thermopiles for measuring radiation are principally the following:

(1) *Constancy of the zero.*—The thermopile must be free from zero errors.

(2) *Quickness in action.*—The ordinary thermopile is a rather slow instrument; when exposed to radiation a constant temperature will be obtained only after a considerable time; for instance, even in the best Rubens thermopile more than 15 seconds elapse before the full electromotive force caused by constant radiation is reached.

(3) *High sensitivity.*—The sensitivity is generally not great enough to make possible the use of the ordinary millivoltmeters instead of the delicate mirror-galvanometers with the photographic recording. However, when great sensibility has been obtained, it has been at the expense of speed.

(4) *Rugged form of construction.*—The existing thermopiles were not sufficiently rugged for the comparatively rough handling they would meet with in practice for permanent solar radiation measurements.

Through the independent efforts in recent years of two distinguished physicists, excellent thermopiles have been constructed, which may be considered to have overcome generally the difficulties in the application of the thermoelectric methods to continuous measurements of solar radiation.

In consequence of these developments, on the one hand by Doctor Coblentz, of the United States Bureau of Standards, at Washington, and, on the other by Dr. W. J. Moll, lecturer on physics at the University of Utrecht, new forms of thermoelectric pyrheliometers have recently been constructed. To this group of recent instruments, based on the use of the new American thermopile, belongs the excellent thermoelectric pyrheliometer constructed at Washington by Prof. H. H. Kimball and Mr. H. E. Hobbs. On the other hand, on the basis of Doctor Moll's thermopile, a new form of thermoelectric recording pyrheliometer has recently been constructed in Europe and was used during my recent actinometric campaign in the Sahara Desert. I give below a short description of this recording pyrheliometer, which is free from zero error, quick in action, very rugged in construction, and easily worked.

It seems that in the future only the simple thermoelectric method will be in current use, with the restriction, of course, that for control purposes special standard instruments (as for instance the water-flow pyrheliometer of Doctor Abbot) must always be recommended in view of the necessity of controlling and comparing solar radiation measurements.

THE PRINCIPAL CHARACTERISTICS OF DOCTOR MOLL'S THERMOPILES

The paramount object in the construction of these thermopiles is to minimize the heat capacity of the active junctions and to give a maximum value to the passive ones.

The elements from which these thermopiles are made are extremely thin strips of manganin and constantan, soldered at *a* and *c* to copper bars (fig. 1.) These strips can be exposed to radiation over their entire length. The good heat conduction between the junctions, and the small capacity of the junction *b*, causes practically an instantaneous equilibrium of temperature in any case in less than two seconds.

The combination manganin-constantan, with a thermoelectric power of about 41 microvolts per 1° C., has been chosen chiefly on account of the high elastic quality of the two metals, which are soldered end to end and rolled out to the thinness of about 0.005 mm. Of importance also is the durability of the metals, which neither rust nor corrode and also the fact that both manganin and constantan have a resistance which is independent of changes of temperature.

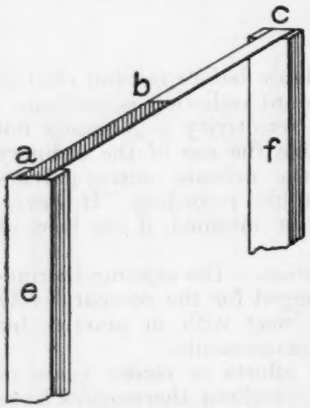


FIG. 1.—Element of Moll thermopile.

Figure 2 is a sketch of the inner part of Moll's thermopile, A is a thick brass plate, in which flattened copper pins B have been clamped. A very thin coating of lacquer forms an insulating layer between these pins and the plate. The thermoelements, soldered on top of the pins, consist of blackened metal strips of only about 5μ (0.005 mm.) in thickness.

All this is sufficient for obtaining both quickness in action and constancy of zero. It is also an important advantage of this construction that the temperature variations do not affect the thermo-electromotive force. An additional advantage is that it is not necessary to screen off the passive junctions; the elements can be exposed to radiation along their full length. Such elements may be combined for building up a linear, just as well as a surface, thermopile.

The large-surface thermopile especially adapted for ordinary measurements of solar radiation intensity, is composed of 80 elements, arranged in three rows and placed in a circle nearly 2 cm. in diameter (fig. 3). The pile, with a resistance of about 45 ohms, is mounted in a solid cylinder which is closed at one end by an ebonite plate with two terminals; and at the other end by a heavy brass lid, into which a protecting window is fixed.

Instead of a rock-salt or ordinary glass window, a plate of fluorite is now used, which transmits all kinds of rays almost without absorption.

The large-surface thermopile of the Moll system gives about 90 microvolts from a candle at one meter distance. The micro-thermopile of 18 elements (suitable for spectral investigations when supplied with a special screen with a slit of variable width) gives about 25 microvolts under the same conditions. Both thermopiles are free from zero errors and combine in an exceptionally rugged form the two properties of great quickness in action with relatively high sensitivity.

THE NEW THERMOELECTRIC PYRHELIOMETER

It follows from the above that the application of the large Moll thermopile for measuring solar radiation gives not only a relatively high thermoelectric current (exceeding sometimes 30 millivolts even when diaphragms are used) but also permits of reaching the final values almost instantly. The solution of the problem of direct and simple recording of the consecutive values of solar radiation intensity, even with the true and quick variations in the corresponding radiation (so frequent especially with cloudy sky) can now be considered as attained, and in a form convenient for general use.

The choice of an appropriate millivoltmeter for direct readings, and especially for automatic records, is an important question chiefly from the practical point of view. The millivoltmeter must not alter the good conditions of sensitivity and quickness of the Moll thermopile; on the other hand, it is highly desirable that the recording millivoltmeter especially should be of simple construction such as the well-known types of Richard's recording instruments.

It is true that the improvement of many details necessitates—chiefly in electrical recording instruments such as millivoltmeters—a certain complication of the construction, as seen in certain new forms of recording voltmeters recently constructed in Europe and in the United States. But, on the other hand, it seems that the simplest form of these instruments is preferable for current use in solar radiation measurements, because they are suitable even for the less experienced observers.

The recording millivoltmeter of Richard, which I have chosen for use with the thermopile of the Moll system, is regularly built for ordinary industrial purposes. It has a resistance of 645 ohms and was used for my radiation measurements with two sensibilities (0–20 and 0–40 millivolts); the clock has two movements; 24 hours and 52 minutes for a complete revolution around the axis. The use of the 24-hour clock allows the observer to keep the instrument in action during the entire day without the necessity of changing the record sheet during this time.

For the maintenance of the thermopile in a position permanently vertical to the solar rays, an equatorially-mounted clock-driven arrangement is used. A special circle serves for the adjustment to the geographical latitude, and a level for the horizontal adjustment. For a quick north-south orientation of the instrument a magnetic needle can also be used.

Figure 4 represents a general view of the thermoelectric recording pyrheliometer [1] and the diaphragmed thermopile equatorially mounted. Instead of a suspension with counterweight, the thermopile may be installed directly on the clock-axis, with provision, however, for a small adjustment in order to follow the variations in the declination of the sun. This must be effected from time to time according to the season.

SOME PYRHELIOMETRIC RECORDS OF THE TOTAL AND PARTIAL INTENSITIES OF SOLAR RADIATION

Without entering into the details which concern more especially physical problems, we note that the voltage of the thermoelectric current generated in the thermopile

[1] This recording pyrheliometer is regularly manufactured, and can be purchased at Etablissements de la Société Jules Richard Paris, 25 Rue Melingue. The actual price is about $250, including the recording millivoltmeter and all the accessories. The recording millivoltmeter costs separately about $100.

(To face p. 300)

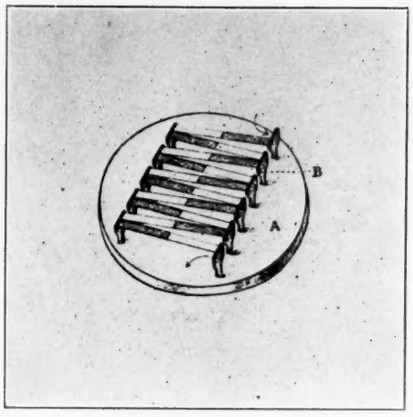


FIG. 2.—Interior view of Moll thermopile

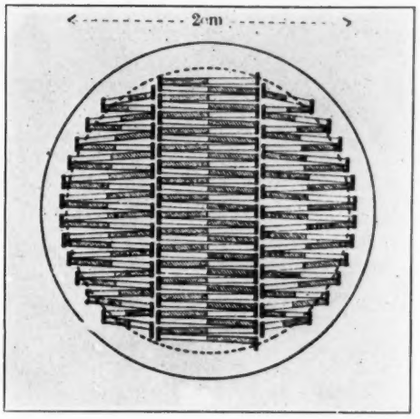


FIG. 3.—Large-surface Moll thermopile

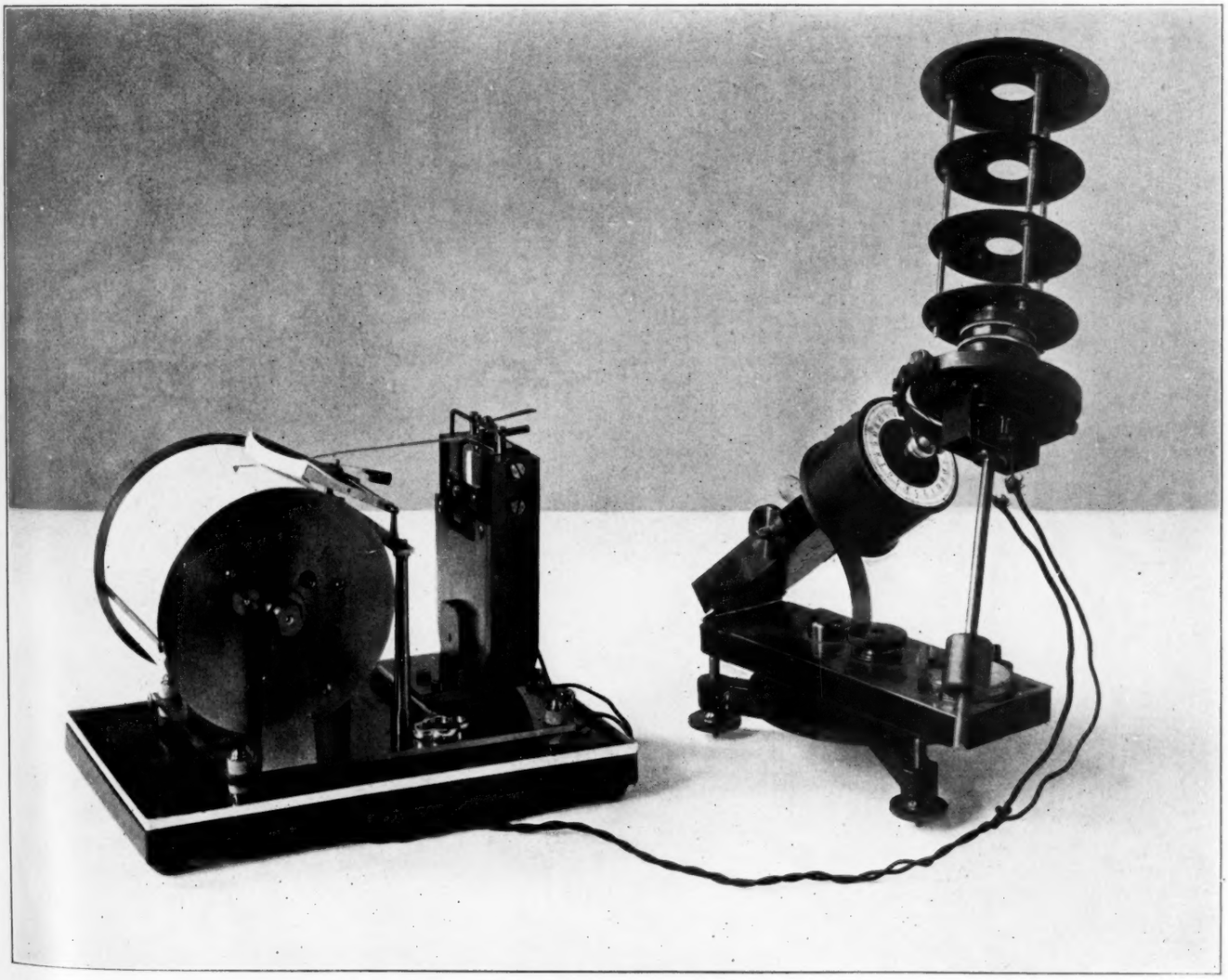


FIG. 4.—General view of recording pyrheliometer

(To face p. 301)

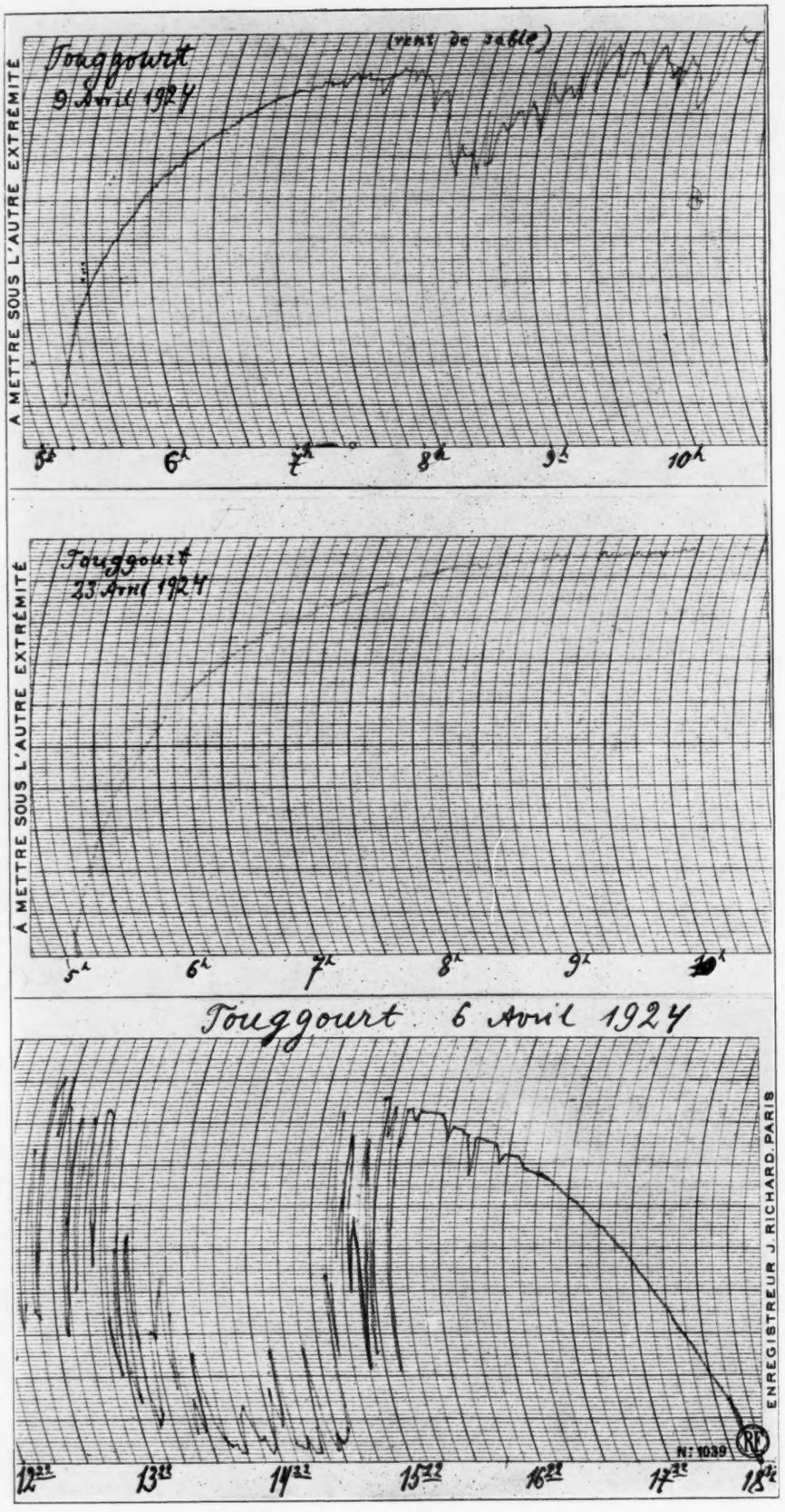


FIG. 5.—Pyrheliometer records obtained in the Desert of Sahara

when exposed to the solar rays can be considered as practically proportional to the radiation intensity. This simple relation enables us to convert directly into gram calories per cm.^{2} per minute the values shown by a millivoltmeter. For this conversion it is necessary previously to obtain the reduction factor for the thermopile used with the corresponding diaphragms; this coefficient can be found either by comparisons with a standard pyrheliometer or by absolute determinations.

We note that with a solar radiation intensity of one gram-calory per minute per square centimeter of surface, the current generated by the large diaphragmed Moll thermopile has a voltage of about 16 millivolts. Besides the thermopile, the millivoltmeters must also be calibrated in order to determine the value of the current indicated by the position of the needle on the diagram. This is done by successively passing currents of 0 to 40 millivolts through the millivoltmeter coils.

Figure 5 gives three examples of pyrheliometric records, obtained by me during the spring of 1924 in North Africa, in the oasis of Touggourt, Desert of Sahara. Owing to the length of the diagrams, only a part of each record is reproduced here.

It is evident from these records that even in the case of frequent passages of clouds the new recording pyrheliometer permits the obtaining of good pyrheliograms, characteristic for the prevalent type of clouds, owing to the quick action of the thermopile. From these records the total amount of radiation, the diurnal march, and average values, can be obtained.

We note finally that not only the total radiation but also the partial intensities of the solar radiation can be easily recorded with the Moll thermopile. For this purpose special light-filters are used which are introduced (by means of a periodical swinging movement) before the aperture of the thermopile.

I have used principally four light-filters, viz:

(1) The so-called marmor glass, opaque for visible rays but with a transmission up to 85 per cent (for thickness of 7.3 mm.) between 0.9 and 2.8μ.

(2) The red glass (Jena F. 4512, thickness 3.95 mm), with a transmission up to 84 per cent between 0.8 and 2.5μ, and opaque below 0.55μ and for the wave-lengths greater than 4.0μ.

(3) The yellow filters prepared by Doctor Moll from 5.16 gr. $K_2Cr_2O_7$ in 100 gr. H_2O. This liquid filter, in a cell 11 mm. thick, transmits up to 98 per cent between 0.7 and 1.2μ, decreasing to 0 per cent for 1.5μ.

(4) The blue filter of 30 gr. $CuSO_4$ in 100 gr. H_2O; it transmits besides short wave-lengths also the radiation of long wave-lengths beginning at 1.8μ.

The use of the light-filters enables us to study, besides the variation of the total intensity, the diurnal changes of the partial intensities of solar radiation. The following extract from the measurements made in the spring of 1924 in the Desert of Sahara, shows some interesting changes in the percentages of the partial intensities in relation to the total intensity of solar radiation.

Oasis of Touggourt, March 28, 1924

(Time: Between 5:52 a. m. and 7:05 a. m.)

Solar zenith distance	Total radiation intensity (gram-cal./cm^2/min.)	Percentages		
		Red infra-red	Infr.	Blue
85½°	0.14	67	19	9
83°	0.25	62	18	10
80°	0.28	58	18	12
75°	0.37	54	17	15
71°	0.40	54	15	17

We see here the characteristic decrease from sunrise to noon in the proportion of the red and infra-red rays and at the same time the consecutive increase of the partial intensity of the solar spectrum.

CONCLUSION

From the considerations indicated above, it follows that the new form of recording thermoelectric pyrheliometer possesses in high degree the desired qualifications, namely, quickness of action, great sensitivity, and absence of zero error. On the other hand, the rugged construction of the thermopile, the simplicity of the whole instrument, and especially of the recording voltmeter, make the new pyrheliometer very easy for current use, not only by the meteorological observatories but also by less experienced observers at ordinary meteorological stations. The results, already obtained in the desert regions of North Africa and in the plains of Europe, as well as comparisons just made between this instrument and the Marvin and the Smithsonian pyrheliometers at Washington, D. C., show its convenience, and the practical adaptation of the measurements obtained with the new recording pyrheliometer in the different climates.

INTERCOMPARISON OF PYRHELIOMETERS

By HERBERT H. KIMBALL, Meteorologist

During a recent visit of Dr. Ladislas Gorczyński, Director of the Meteorological Service of Poland, to the Central Office of the United States Weather Bureau, an opportunity was afforded to obtain interesting comparisons between several different types of pyrheliometers,[1] the results of which are given in Table 1.

TABLE 1.—*Comparison of Marvin Silver Disk pyrheliometer, with Moll and Weather Bureau thermoelectric recording pyrheliometers, June 7, 1924*

Solar time	Marvin No. 3 (gr.-cal.)	Thermoelectric pyrheliometers			Ratio, columns 2/4	Ratio, columns 2/5
		Moll		Weather Bureau scale		
		Scale	Millivolts			
(1)	(2)	(3)	(4)	(5)	(6)	(7)
0:28	1.198	5.19	20.76	17.5	0.0576	3.37
0:32	1.184	5.13	20.52	17.2	578	3.35
1:03	1.214	5.31	21.24	18.2	573	3.43
1:07	1.216	5.32	21.28	18.2	571	3.43
1:11	1.204	5.27	21.08	18.0	570	3.42
1:15	1.186	5.20	20.80	17.8	570	3.42
1:19	1.197	5.20	20.80	18.05	575	3.47
1:23	1.182	5.17	20.68	18.0	571	3.48
1:27	1.169	5.13	20.52	17.65	570	3.44
1:31	1.165	5.13	20.52	17.6	568	3.43
1:35	1.172	5.11	20.44	17.85	574	3.49
1:39	1.168	5.09	20.36	18.8	573	3.50
1:43	1.157	5.04	20.16	17.6	573	3.49
Mean ratio					0.0572	3.44

Ångström pyrheliometer No. 105, which was in use at Mount Weather, Va., from 1907 to 1911, and Smithsonian Silver Disk No. 1, were also included in the above comparison. Dr. Gorczyński read Ångström No. 105, and the Smithsonian instrument was read by myself. The Ångström readings were in almost exact agreement with the readings of Marvin No. 3. The Smithsonian instrument, unfortunately, had recently been returned from field work, and the screws that clamp the silver disk during shipment had not been loosened. In consequence, the Smithsonian instrument read low.

Since the departure of Doctor Gorczyński the following comparisons have been obtained between Marvin No. 3 and Smithsonian No. 1.

TABLE 2.—*Comparisons between Marvin Silver Disk Pyrheliometer No. 3 and Smithsonian Silver Disk No. 1*

Date	Smithsonian No. 1	Marvin No. 3	Ratio, Marvin / Smithsonian
	Gr. cal.	Gr. cal.	
June 20	1.030	1.006	0.977
June 25	1.172	1.140	0.973
June 26	1.294	1.267	0.979
June 26	1.318	1.281	0.972
Mean ratio			0.975

Through comparison of the Moll thermoelectric pyrheliometer with an Ångström pyrheliometer reserved by him as a substandard instrument Doctor Gorczyński had previously obtained the factor 0.057 to reduce millivolts recorded by the Moll instrument to gram-calories. Therefore, the comparisons of Table 1 confirm the accuracy of this factor.

From Table 2 it appears that the Marvin pyrheliometer in June, 1924, was reading 2.5 per cent lower than Smithsonian No. 1. Previous comparisons had shown that Ångström No. 105 read 2.4 per cent lower than Smithsonian No. 1. Therefore, as the result of the above comparisons, we conclude that the Moll instrument is still in accord with the Ångström standard, but reads 2.5 per cent lower than the Smithsonian pyrheliometric scale.[2]

It is important to correlate the readings of this Moll instrument with the Smithsonian pyrheliometric scale, since it has been loaned by Doctor Gorczyński to Mr. Andrew Thompson, Director of the Samoan Magnetic and Meteorological Observatory, for use at that island station.

[1] Published descriptions of these several instruments will be found as follows: Ångström pyrheliometer: Astrophysical Jr., 9: 332-335; Smithsonian Silver Disk pyrheliometer: Annals of the Astrophysical Observatory of the Smithsonian Institution, 3: 47-52; Marvin Silver Disk pyrheliometer: MONTHLY WEATHER REVIEW, 1919, 47, 769. Weather Bureau thermoelectric pyrheliometer: MONTHLY WEATHER REVIEW, 1923, 51: 239-242 Moll thermoelectric pyrheliometer, MONTHLY WEATHER REVIEW, 1924, 52: 299-301.

[2] Smithsonian pyrheliometry revised. Smithsonian Misc. Coll. Vol. 60, No. 18 1913.

INVESTIGATIONS RELATIVE TO THE POLAR FRONT[3]

By J. W. SANDSTRÖM

In connection with the earlier investigations[4] an attempt was made to apply the theory of "cyclone families" in practical weather service work. This test proved especially fruitful of results since the theory contains a very simple and clearly formulated law as to the paths of cyclones. The result of the test was followed with lively expectation.

The theory of cyclone families states, as is well known, that successive cyclones appear in families, so to speak, and with the succeeding depression having its path somewhat to the south of that of the preceding one, until finally the cyclones move tangent to the tropical belt of high pressure. The first members of the family appear in high latitudes and run more and more to the south until they come so far south that cyclonic formation becomes no longer possible. The theory is a consequence of the polar front conception. A cyclone draws the cold polar air behind it and brings the polar front to the south of its own center, and since the succeeding cyclone follows the polar front it must move more to the south. The process is shown by J. Bjerknes and H. Solberg in Figure 12 of their work, "Life Cycle of Cyclones and the Polar Front Theory of Atmospheric Circulation."[5]

The application of the theory in practical weather service is, then, simple enough. From the known path of a cyclone that has just passed, one draws the path of the succeeding cyclone somewhat more to the south and thereby obtains within relatively narrow limits the path which the next depression will take. Only when the path runs in the vicinity of the tropical "high" is there

[3] Translated from *Meteorologische Zeitschrift, Band 41, Heft 2* (February, 1924) by W. W. Reed.

[4] *Meteorologische Zeitschrift, Band 40, Heft 9* (September, 1923).

[5] *Geofysiske Publikationer, Vol. III, Nr. 1*, 1922.

no succeeding more southerly cyclone to be expected, but attention must be turned to the north, where a new cyclone family is already active. These new cyclonic paths will behave in the same way as did those of the earlier family. Although in this process, as in all other meteorological phenomena, there are exhibited all kinds of irregularities, it is clear that a law concerning cyclonic paths stated so precisely must be very valuable in practical weather service work, since certainty in weather prediction always depends essentially on correct judgment as to the path of an approaching cyclone.

On the basis of this law I sought to draw in advance the paths of coming cyclones. However, it soon appeared that they did not follow the paths thus drawn, but took paths altogether different. After several attempts were made with poor success, I then had carried out at my institute a detailed investigation on the basis of Hoffmeyer's charts, which were very well adapted to the purpose. At first two statistical methods were employed. If the law is correct, it must happen that the path of the succeeding cyclone lies much more often to the south than to the north of that of the earlier cyclone. The tabulation showed, however, no noteworthy difference. Further, in case the law is correct the north-south distance between two successive cyclonic paths must be far greater when the path of a depression lies to the north than when it is situated to the south of the path previously charted. Here, also, the measurements gave no differences worth mentioning.

In this investigation a large number of Hoffmeyer's charts were used. They were considered according to months as is shown in Figures 1 and 2 (not reproduced). On these charts the dots show the positions of the cyclone, the number below a dot giving the day of the month on which the center was situated at that point and the connecting lines indicating the cyclonic path.

If these charts are examined closely, it is found, even without statistical treatment, that the paths of the successive cyclones do not have, as a rule, the same form as that found for preceding disturbances and that often later paths intersect earlier ones in all kinds of ways. In the cases in which they do run parallel it happens that the succeeding path lies a little to the north just as often as it lies a little to the south. On the whole, no confirmation of the law of cyclone families can be gathered from these charts.

I recommend that every meteorologist who is interested in the practical application of the ingenious exposition by Bjerknes—and all who are engaged in weather forecasting should be interested—proceed further with this elaboration of the Hoffmeyer charts; it is easily done and is productive of results. I believe that they, with me, will gradually arrive at the convictions (1) that cyclone families in the Bjerknes sense do not exist, (2) that the behavior of cyclones is not regulated by a polar front, and (3) that the discontinuity, which is called the polar front, appears, in general, only with the cyclones and is a result of their activity.

Meteorological processes depend to a large degree on the distribution of land and water and on the topography of the land. A theory that omits these important elements and takes into consideration only the influence of latitude must necessarily be incomplete. This circumstance is probably the main reason for the lack of success that appears in the practical application of the Bjerknes theory.

I do not mean to say by this that such abstractions should be avoided. On the contrary, by such an abstract treatment of a certain single influence, the consequences of the same follow far more clearly and simply than when it is considered together with other influences. Care should be taken not to accept the partial and qualified results obtained in this way as a general and exclusive basis for practical work.

If I use here the method employed by Bjerknes, it is not only to obtain a direct comparison with his results, but also because I find this method better than all others. However, my results may not be used as a foundation in weather service work until the decisive influences of topography and distribution of land and sea are taken into consideration.

When the temperature data from the European yearbooks issued before the war are entered on synoptic charts, the horizontal temperature gradient can be measured with great accuracy. Even in non-cyclonic weather there are then found numerous small, abrupt changes in temperature distribution, which can hardly be explained otherwise than by slightly marked discontinuities. In general the lines of discontinuity run with the isotherms and appear to have their cause in the movement of the air relative to the isotherms. Such discontinuities are to be expected in the area between the regions of polar and tropical air; in this area the horizontal temperature gradient and the movement relative to the isothermal lines are considerable. As a matter of fact, this can be demonstrated on the Hoffmeyer charts despite the small number of temperature stations. If the influence of land and sea is excluded and latitude alone is taken into consideration, then in non-cyclonic weather these lines of discontinuity will run with the parallels as represented in Figure 3 (not reproduced). According to my view this wide zone of discontinuities should be substituted for the Bjerknes polar front.

In this view the cyclones are produced by differences in velocity of the air currents relative to each other somewhat in the same manner as rotating water whirls in rivers and other currents.

According to the above investigation relative to cyclone families, the successive cyclones have little or no connection among themselves. As the result of different specific gravities and considerable differences in velocity of the air currents relative to each other, there are developed, as a rule, marked discontinuities according to the Bjerknes scheme. Figure 4 (not reproduced) shows these lines of marked discontinuity and in addition the manner in which the lines of Figure 3, indicating less abrupt discontinuity, have been distorted by the cyclone.

In Sweden the defects of the Bjerknes theory stand forth prominently in those cases where the distribution of land and water is especially influential on the weather; such is often the case in our land (Norway). Among the cyclones that are very deceptive on account of this distribution are those that form over the Baltic Sea or stagnate there and bring the well-known three-day rains over eastern Sweden. These cyclones are not formed according to the Bjerknes scheme or have lost that structure if once they possessed it. If, in despite of this, predictions are made according to the Bjerknes scheme, they will in general prove erroneous.

* * * * *

[The paper concludes with a discussion of charts showing the weather in Sweden for June 18–19, 1921. In this there is pointed out the failure of the prediction according to the Bjerknes plan, and the statement is made that it would have been far better to have applied an old empirical rule which would have prognosticated the weather correctly.—Ed.]

THE SO-CALLED MONSOONAL WINDS OF TEXAS

By ALFRED J. HENRY, Meteorologist

The attention of early students of the wind systems of the United States was soon drawn to the seasonal change in direction of the winds of certain localities. Blodget [6] was among the first to point out this characteristic. He says, discussing the winds of the Gulf of Mexico and adjacent regions:

> Westward of New Orleans they [the winds] are much stronger and more nearly continuous than eastward, and on the coast of southwestern Texas they develop something very near a monsoon, as the term is used and understood in discussing the climate of the Eastern Hemisphere.

The late Prof. Mark Harrington discussed the subject in a paper presented before the Philosophical Society of Washington in 1894, under the title "The Texas Monsoons." [7]

A careful reading of Harrington's paper discloses the fact that he classed as monsoon winds all of those which had a more or less well-marked seasonal change in direction from land to sea and vice versa. Thus, he indicated six different regions in the United States which according to his concept were characterized by monsoon winds. His ideas were apparently not very definite, since he uses the term "periodic winds" interchangeably with "monsoon" winds.

The regions he so classed are as follows:

1. The Texas monsoons, extending up the plains sometimes beyond the limits of Texas and even to the northern boundary of the United States.
2. California monsoons, occurring on the Pacific coast south of San Francisco and reaching up the Sacramento and San Joaquin valleys.
3. The Willamette and Puget Sound periodic winds.
4. The northeast and southwest winds of the Atlantic coast.
5. The offshore winds above Cape Henry.
6. Isolated cases at Escanaba, Duluth, Las Animas, and Winnemucca.

A more rational classification of these winds would assign them as members of the general atmospheric circulation in the zone of prevailing westerly winds. These winds owe their seasonal change partly to local and partly to general causes and should not be confused with the monsoon winds of southern and southeastern Asia.

It may be said on behalf of the earlier writers that they were not in possession of adequate data. Nevertheless, Ferrel, than whom no other was better qualified to analyze the physical causes which produce monsoon winds, carefully avoided classifying the winds of any portion of the United States as monsoonal. He says: [8]

> On the continent of North America we have monsoon influences similar to those of Asia, but not nearly so strong, because the extent of the continent and, consequently, the annual range of temperature is not so great. They are, for the most part, not sufficiently strong to completely overcome and reverse the current of the general circulation of the atmosphere and so to produce a real monsoon, but they cause great differences between the prevailing direction of the winter and summer winds.

The word "monsoon" is from the Arabic, meaning "a time, or season." It may be defined as a term which is used to designate certain winds which blow with great persistence and regularity in opposite directions at different seasons of the year. In its true sense it is applied only to those great systems of inflowing and outflowing winds which so greatly modify the climate of southern and southeastern Asia. Professor Ward [9] recognizes this fact and has stated in his discussion of the winds of the United States that monsoon winds in the Indian sense do not occur in the United Sattes.

THE SURFACE WINDS OF TEXAS

The records of the Weather Bureau station at Galveston, Tex., have been used as the most representative station on the Texas coast. The prevailing direction of the wind at that station as compiled by Section Director L. H. Murdoch, and published in Weather Bureau Bulletin Q—Climatology of the United States, page 437—is from the southeast in all months of the year, except June, July, and August, when it is from the south. The accuracy of this record, which is based on eye observations made bidaily and for a time tridaily, may be checked by a comparison with results based on hourly observations as given by automatically recording instruments. Such a record based on a 5-year average is printed in the Annual Report of the Chief of Weather Bureau, 1896–97, page 115. From it the data of Table 1 have been obtained.

TABLE 1.—*Average duration of wind in hours, from each of the eight principal points of the compass, Galveston, Tex., for the five years 1891–1895*

[From Annual Report Chief Weather Bureau, 1896–97, p. 115]

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
N	92	94	82	43	49	18	12	25	39	70	74	89	688
S	108	105	124	185	232	**229**	**258**	**195**	102	78	118	136	1,865
NE	105	107	105	48	77	47	34	59	152	163	106	92	1,094
SW	61	50	65	50	71	117	233	193	35	61	86	70	1,092
E	70	80	57	53	30	43	27	44	103	97	105	66	776
W	27	21	12	17	5	27	23	54	6	17	27	33	269
SE	**157**	**144**	**240**	**290**	**250**	223	136	131	**258**	**205**	**122**	**160**	2,318
NW	111	72	58	33	29	15	26	40	21	48	79	96	627

The data of the above table have been arranged in pairs of contrasted directions for ease of comparison.

The prevailing direction for each month is shown by the figures in bold-faced type, and it is seen at once that in every case the prevailing direction as obtained from eye observations is confirmed; it is also seen that the duration of south winds is nearly three times as great as for north winds; this proportion also holds in the case of east and west winds and southeast and northwest winds. The latter stand in the greatest contrast to each other among all the pairs of wind directions.

In no case is there what can be called a distinct reversal of the surface wind direction in the sense that the great seasonal increase in southerly winds is associated with a correspondingly great increase in the northerly winds of winter.

FREE AIR WINDS OVER TEXAS AND TO THE NORTH

For a number of years it has been a matter of common knowledge among the Washington forecasters that at

[6] Blodget's Climatology of the U. S. 1857, p. 364.
[7] Philosophical Society of Washington Bull. Vol. XII, pp. 293–308.
[8] W. Ferrel, A popular treatise of the winds, p. 214.
[9] Ward, R. DeC., Annals, Association Amer. Geographers, 1916, p. 111.

times a high current from the southwest, as evidenced by the movement of high clouds, prevails over Texas, New Mexico, and adjoining States of the Southwest. This movement under favorable conditions was useful as a precept for a rain forecast in Mississippi Valley States.[10]

It is not surprising, therefore, that the free-air kite records should confirm the existence of this southwest current at levels much lower than those indicated by Ci. and other forms of high clouds. Two kite stations are available—Groesbeck, Tex., about 200 miles inland from the Gulf of Mexico, and Broken Arrow, Okla., about 300 miles farther inland in an almost direct north-south line with Groesbeck. Part of the data used have already been printed in WEATHER REVIEW SUPPLEMENT No. 20—An Aerological Survey of the United States (Tables 13a and 13d)—and the data necessary to bring the material down to date has been kindly supplied by the Aerological Section from manuscript reports. In SUPPLEMENT No. 20 the data are presented for each of 16 points of the compass. In order to reduce the labor of analyzing the whole mass of data for each direction I have selected a single pair of oppositely-directed winds for presentation, viz, southwest and northeast winds. And I have combined with those directions the data for the two immediately adjacent points of the compass, thus NNE. and ENE. have been combined with NE. in the one case and SSW. and WSW. with SW. in the other case. The percentage frequency of the winds up to 4 km. for NE. and SW. are given in the table below.

TABLE 2.—*Frequency in percentages of winds from the directions and at the levels named at the Kite stations of Groesbeck, Tex., and Broken Arrow, Okla.*

SPRING

Altitude above m. s. l. in m.	Groesbeck						Broken Arrow					
	141 (surf.)	1,000	1,500	2,000	3,000	4,000	233 (surf.)	1,000	1,500	2,000	3,000	4,000
Whole number of observations	493	459	404	348	190	44	430	422	378	328	151	28
NNE, NE, ENE	14	10	7	5	4	0	14	12	9	8	5	0
SSW, SW, WSW	21	34	41	48	60	50	18	35	45	51	47	36

SUMMER

Whole number of observations	419	377	317	262	114	33	321	313	275	239	129	30
NNE, NE, ENE	5	6	5	4	5	9	9	8	6	6	3	0
SSW, SW, WSW	48	56	57	52	42	27	32	51	56	57	53	57

[10] Cf. Weather forecasting in the United States, p. 287.

TABLE 2.—*Frequency in percentages of winds from the directions and at the levels named at the Kite stations of Groesbeck, Tex., and Broken Arrow, Okla.*—Continued

AUTUMN

Altitude above m. s. l. in m.	Groesbeck						Broken Arrow					
	141 (surf.)	1,000	1,500	2,000	3,000	4,000	233 (surf.)	1,000	1,500	2,000	3,000	4,000
Whole number of observations	496	454	394	376	236	80	385	372	329	279	157	51
NNE, NE, ENE	19	20	15	9	7	9	13	15	12	5	4	2
SSW, SW, WSW	18	29	33	35	39	46	21	38	45	52	55	48

WINTER

Whole number of observations	485	436	385	329	213	61	370	361	292	234	109	20
NNE, NE, ENE	17	13	5	3	1	0	15	18	10	5	1	0
WSW, SW, WSW	24	36	43	43	45	43	20	37	40	39	36	30

The outstanding feature of the above table is the great contrast between the frequency of southwest and northeast winds in all seasons and at both stations. There is no reversal in the ordinary meaning of that word, but rather the southwest current increases greatly in frequency in spring, reaches a maximum in summer, and diminishes somewhat in winter, but remains the dominant current even in winter. Northeast winds are most frequent in winter, but even then they are much less frequent than southwest winds.

Broken Arrow, being farther inland than Groesbeck, and consequently having more of a continental climate, shows more of the influence of the seasonal change in winds and temperature than does Groesbeck. In winter, for example, at the 2 km. level at Groesbeck 28 per cent of the winds are from the northwest and but 5 per cent from the southeast; at Broken Arrow the percentage of northwest winds is 31 against but 1 per cent from the southeast.

The percentage for summer for the 2 km. level are Groesbeck SE. 18, NW. 7, Broken Arrow SE. 8, NW. 5, values too small to be embraced under the term "monsoon" winds, although there is a sharp change in direction due to seasonal changes in temperature over the continent and adjacent water surfaces.

THE COTTON PLANT IN RELATION TO TEMPERATURE AND RAINFALL

By J. B. KINCER

The cotton plant is of tropical origin, but is now grown in many places between latitudes 40° N. and 30° S. In most forms it is a perennial shrub, but changes its habits of growth where cultivated in more northern regions. Cotton is slow growing and has a long fruiting season, and consequently requires at least six months free from frost; the weather should be warm, both day and night.

While cotton requires considerable moisture during the growing period, too much rainfall or cloudy weather is detrimental, especially during the harvest season. Successful cultivation is limited more by the prevailing temperature and the length of the growing season than by rainfall, as cotton is produced under widely varying moisture conditions.

In a recent publication, Bulletin No. 32 of the Ministry of Agriculture of Egypt, Mr. C. B. Williams presents two graphs, which bring out some interesting relations between climatic conditions and the growth of cotton. These are reproduced herewith. The countries and representative stations for which records are shown are as follows:

Egypt: Cairo.
Sudan: Tokar.
India: Madras.
Turkestan: Tashkent.
Nigeria: Lagos.
Texas: Abilene.
Mesopotamia: Bagdad.

Figure 1 shows the relation between the temperature and the growth of cotton for the principal producing countries, the records being so adjusted as to bring the periods of planting, growth, and harvest and also of the closed season for the several countries in comparable positions on the chart. The first space shows temperature conditions, in mean monthly values, between the periods of growth; that is, when no cotton is on the land. The second space shows conditions from the time of planting to the beginning of harvest, the line to the left indicating the dates of planting and that to the right the beginning of harvest. The third space shows conditions during the picking season; and, finally, the last space is a reproduction of the first, or the rest period. The numerals indicate the respective months which are arranged to synchronize the successive epochs of growth.

With respect to temperature, cotton is grown under three general conditions:

(1) During the warm season of the year between two periods of low temperatures, such as in Egypt, the United States, Turkestan, Mesopotamia, and other countries. Here cotton is a summer crop.

(2) During the cool season, or between two periods of high temperature, such as in the Sudan and Madras, where it is a winter crop.

(3) Where the temperature is more or less constant throughout the year and is not the determining factor for the season of growth, such as Madeira, Brazil, and the Hawaiian Islands.

Where cotton is a summer crop it is planted on a rising temperature, Figure 1 showing that this usually varies from about 50° to 65°. Where it is a winter crop, planting is accomplished with considerably higher, but falling temperatures, ranging mostly between 75° and 85°. In nearly all cases, however, the temperature conditions become rather uniform soon after the beginning of growth, the mean daily value ranging between 75° and 80°, as a rule. At the beginning of picking the temperatures again diverge and they differ widely by the time harvest is completed. Mesopotamia varies considerably from the other countries shown on the diagram in that temperatures are considerably higher during the latter part of the period of growth. This usually necessitates heavy watering.

Figure 2 shows, in the same manner as Figure 1, the rainfall conditions in the several countries. This chart clearly shows why in Nigeria cotton is grown during the latter half of the calendar year, notwithstanding that temperatures are favorable throughout the year. The rainfall is entirely too heavy during the other months. The outstanding characteristic of this chart is the constantly and uniformly small amounts of rainfall during the picking season, which is a necessary condition for success in cotton growing.

There is also included on Figure 2 the amount of irrigation water used under normal rainfall in Egypt. It will be seen that considerably more water is given by irrigation during the latter part of the period of development than occurs naturally in nonirrigated countries. This is due to the fact that more water is required when artificially applied under dry atmospheric conditions and constant sunshine than when naturally precipitated. The latter is necessarily accompanied by cloudy skies and higher humidity which favor low evaporation and, consequently, less water is lost. It is stated that in Mesopotamia 13 successive waterings are given and that the total amount usually applied to the cotton crop annually is about 52 inches. This unusually heavy watering is made necessary by the prevailing high temperatures and sunshiny weather.

In the case of India, it will be noted that the rainfall values during the growth period are materially different from those in other cases. This is due largely to a rather unfortunate selection of meteorological records, for the city of Madras does not well represent the larger cotton-producing section of that country. While the highest grade of cotton is grown in the southern part of the Province of Madras, much the greater portion of it comes from the west-central Provinces of India, from the Nerbudda and Tapti Valleys, or from the Bombay presidency, Baroda and Berar. In these sections rainfall differs materially from that on the coast of Madras, which is represented in the graph by the records of the city of that name. In these central-western Provinces rainfall is much lighter, the annual amounts being usually about 30 to 35 inches, with the rainy season beginning in June and ending in October. Again in the southern inland portion of the cotton-producing section of Madras, the rainfall is also considerably lighter than on the coast, the October amounts averaging around 8 inches and the November 6 to 7 inches, or little more than one-half as heavy as that shown on the graph.

With respect to the United States, the precipitation shown represents the amount occurring in the extreme western portion of the cotton-growing area (Abilene, Tex.), and this again does not well represent moisture conditions in much the greater portion of the American Cotton Belt. In the central and eastern cotton-growing districts precipitation is much heavier, but at the same time the seasonal distribution holds very well. That is, there is usually less rainfall during the picking season than during the period of active growth.

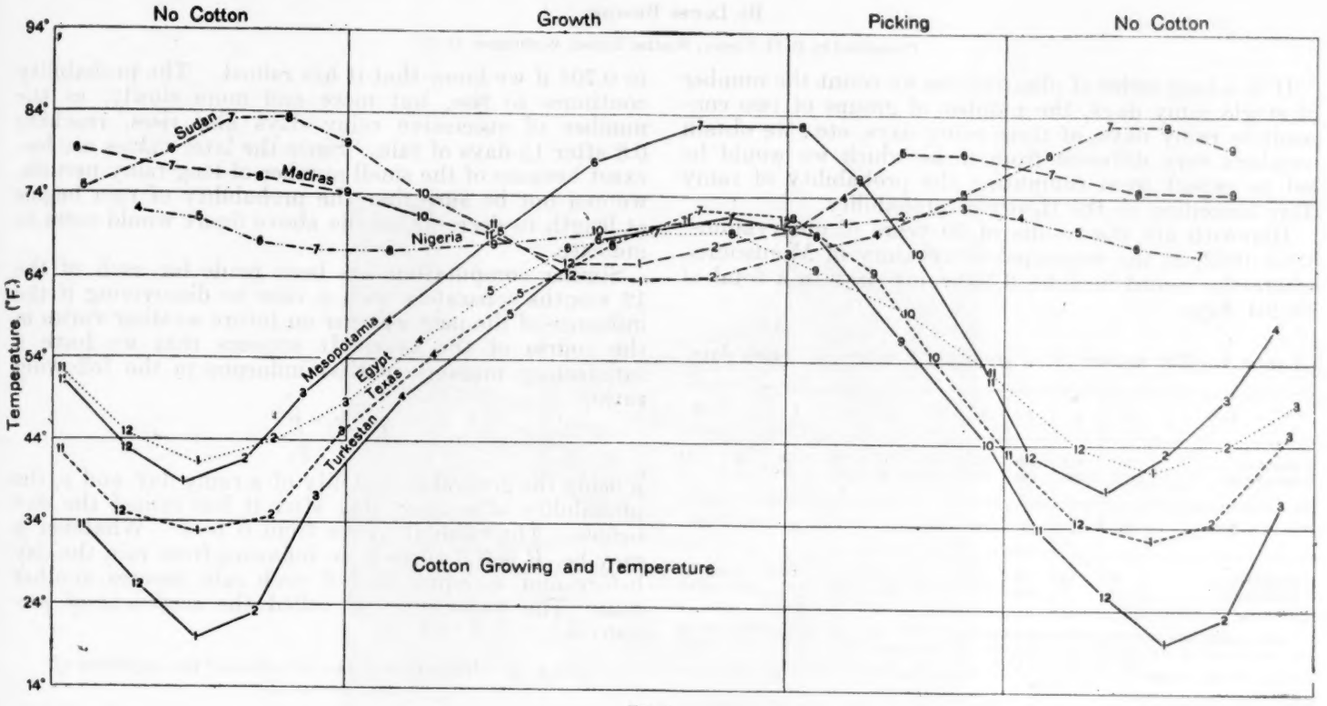

No Cotton
Growth
Picking
No Cotton
94°
84°
74°
64°
54°
44°
34°
24°
14°
Temperature (°F.)
Sudan
Madras
Nigeria
Mesopotamia
Egypt
Texas
Turkestan
Cotton Growing and Temperature

FIG. 1

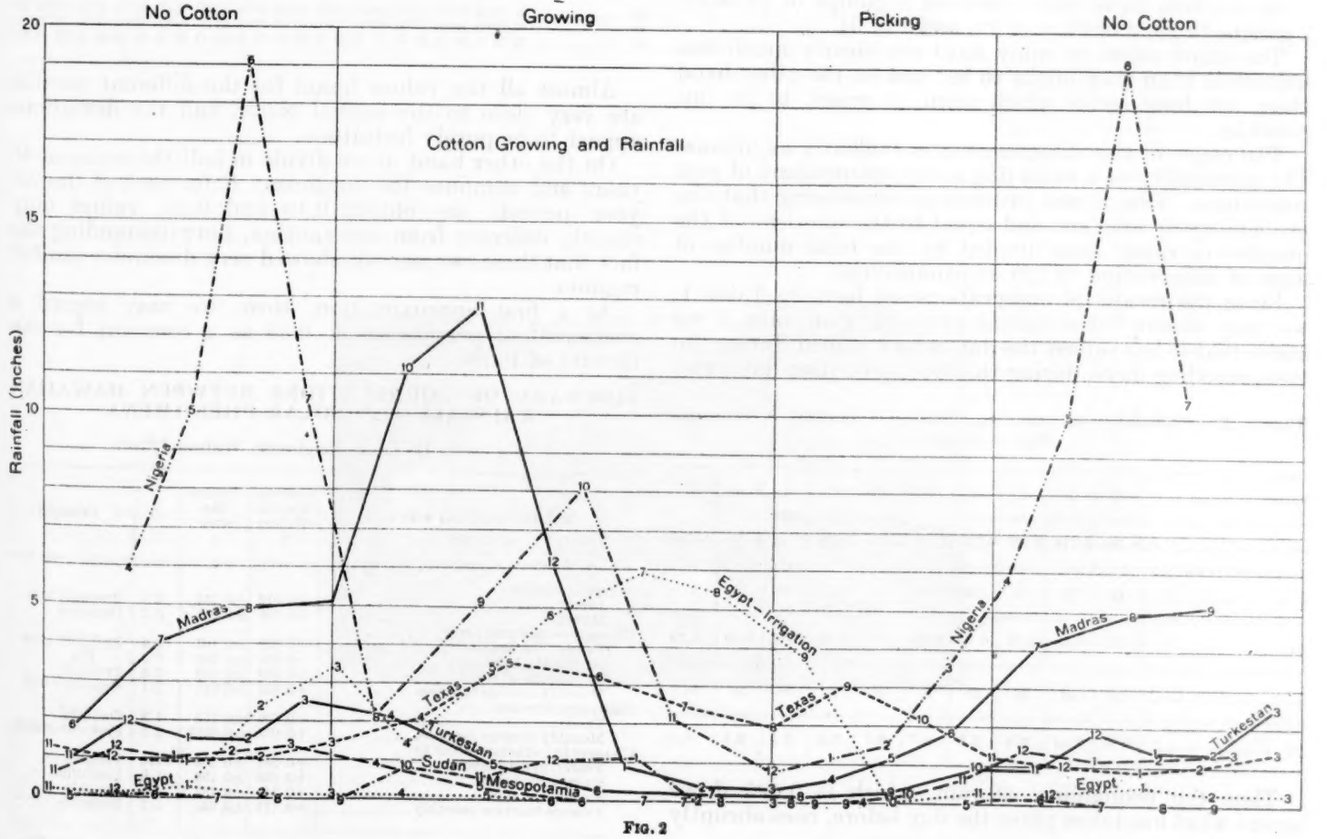

No Cotton
Growing
Picking
No Cotton
20
15
10
5
0
Rainfall (Inches)
Cotton Growing and Rainfall
Nigeria
Madras
Egypt - Irrigation
Texas
Turkestan
Sudan
Mesopotamia
Egypt

FIG. 2

ON THE PROBABILITY OF RAIN [11]

By LOUIS BESSON

[Translated by B. M. Varney, Weather Bureau, Washington, D. C.]

If in a long series of observations we count the number of single rainy days, the number of groups of two consecutive rainy days, of three rainy days, etc., we obtain numbers very different from those which we would be led to expect from computing the probability of rainy days according to the theory of probability.

Herewith are the results of 50 years of observations, 1873–1922, at the municipal observatory of Montsouris, where the record includes 9,580 rainy days in a total of 18,261 days.

TABLE 1.—*The number, S, of groups of k consecutive rainy days*

k	1	2	3	4	5	6	7	8	9	10
S observed	917	614	389	263	181	117	99	63	59	34
S calculated [1]	2,165	1,136	596	313	164	86	45	24	12	7

k	11	12	13	14	15	16	17	18	19	20
S observed	27	19	14	14	6	6	6	1	2	4
S calculated	3	2	0.9	0.5	0.3	0.1	0.07	0.04	0.02	0.01

[1] Let n equal the number of rainy days in a series of N days. If we assume that all the permutations are equally probable, we find the mean number of single rainy days in N days to be $\frac{(N-n)\ (N-n+1)\ n}{N\ (N-1)}$; that of groups of two rainy days to be $\frac{(N-n)\ (N-n+1)\ n\ (n-1)}{N\ (N-1)\ (N-2)}$, and so on. These formulae were given by Grossmann (Achiv der Deutsche Seewarte, 23, Jahrg., 1900, p. 34).

In addition there were observed 3 groups of 21 days, 2 groups of 25, 2 of 27, 1 of 29, and 1 of 31.

The short series of rainy days are clearly much less numerous than they ought to be; and on the other hand there are long series which seem, *a priori*, to be impossible.

The cause of this disagreement is evidently as follows: The probability of a rainy day is not independent of past conditions. One is not justified in considering that the probability is constant and equal to the quotient of the number of rainy days divided by the total number of days of observation (0.525 at Montsouris).

From the results of observations set forth in Table 1, we may derive [12] the actual probability of rain if we know that it has rained the day before, rained during the two preceding days, during the three preceding days, etc.

TABLE 2.—*Probability of rain, p_k, when the number, k, of rainy days is known*

k	1	2	3	4	5	6	7	8	9	10
p_k	0.704	0.714	0.727	0.737	0.744	0.751	0.749	0.756	0.754	0.769

k	11	12	13	14	15	16	17	18	19	20
p_k	0.772	0.78	0.78	0.78	0.81	0.80	0.81	0.82	0.80	0.78

k	21	22	23	24	25	26	27	28	29	30
p_k	0.81	0.84	0.8	0.8	0.7	0.7	0.6	0.7	0.5	0.5

Thus the probability of rain, which is 0.525 if we ignore what has taken place the day before, rises abruptly to 0.704 if we know that it has rained. The probability continues to rise, but more and more slowly, as the number of successive rainy days also rises, reaching 0.8 after 15 days of rain. Since the later values are less exact because of the small number of long rainy periods, we can not be sure that the probability of rain begins at length to decrease, as the above figure would seem to indicate.

Similar computation has been made for each of the 12 months separately with a view to discovering if the influence of the past weather on future weather varies in the course of the year. It appears that we have a satisfactory measure of that influence in the following ratio:

$$R=\frac{p_1-p}{1-p_1},$$

p being the general probability of a rainy day and p_1 the probability of a rainy day after it has rained the day before. The ratio R varies from 0 to 1. Whatever p may be, R is 0 if there is no influence from rain the day before and is equal to 1 if such rain assures another rain. This ratio may be called the *coefficient of persistence*.

TABLE 3.—*Monthly and annual values of the coefficient of persistence R.*

	J	F	M	A	M	J	J	A	S	O	N	D	Year
p	0.582	0.558	0.551	0.530	0.499	0.476	0.470	0.456	0.452	0.529	0.574	0.618	0.525
p_1	0.708	0.760	0.713	0.693	0.742	0.650	0.679	0.641	0.649	0.688	0.762	0.767	0.704
R	0.36	0.46	0.36	0.35	0.49	0.33	0.39	0.34	0.36	0.34	0.44	0.39	0.38

Almost all the values found for the different months are very close to the annual mean, and the deviations appear to be purely fortuitous.

On the other hand, if we divide in half the series of 50 years and compute the coefficient R for each of the 25-year periods, we obtain 0.40 and 0.35, values only slightly different from one another, notwithstanding the fact that these two periods showed very dissimilar rainfall regimes.

As a first approximation, then, we may regard a coefficient of persistence of 0.38 as a constant for the climate of Paris.

[11] Comptes Rendus, 178, no. 21, May 19, 1924, pp. 1743–1745.

[12] It is clear that if we designate as S_k the number of groups of K consecutive rainy days, and by p_k the probability of rain after k days of rain, n being always the total number of rainy days, we have:

$$p_1=\frac{S_2+2S_3+3S_4+\cdots}{n},\quad p_2=\frac{S_3+2S_4+3S_5+\cdots}{S_2+2S_3+3S_4+},\text{ etc.}$$

SUMMARY OF CORRELATIONS BETWEEN HAWAIIAN RAINFALL AND SOLAR PHENOMENA

By JOEL B. COX, Engineer, Wailoa Ditch

Rainfall correlated with—	Correlation coefficient r	Probable error e	r/e	Remarks
Sunspot numbers:				
Yearly	−0.012	±0.164	0.1	Probably none.
Monthly	+0.159	±0.043	3.7	Doubtful.
Changes in spot numbers:				
Yearly, synchronous	+0.070	±0.163	0.4	Probably none.
Six months before	−0.056	±0.164	0.3	Do.
Six months after	+0.459	±0.130	3.5	Probable.
Monthly average function	+0.092	±0.044	2.1	Possibly small.
Radiation intensity:				
Yearly	−0.200	±0.153	1.3	Doubtful.
Monthly average function	+0.077	±0.0313	2.5	Probable (small).
Changes in radiation intens ty:				
Yearly, synchronous	+0.245	±0.152	1.6	Possible.
Six months before	+0.165	±0.158	1.0	Doubtful.
Six months after	+0.249	±0.152	1.6	Possible.
Average function monthly	+0.176	±0.031	5.7	Probable.

NOTE.—The above correlation coefficients were furnished by Mr. Cox in connection with some related work; they are published for the benefit of those interested in correlation between solar and terrestrial data.—EDITOR.

(To face p. 308)

FIG. 1.—Lorain, Ohio, after tornado of June 28, 1924; Broadway, looking south

FIG. 2.—Wreckage in Lorain, seen from a high roof

(To face p. 309)

FIG. 3.—Part of Lorain's business district, greatly damaged by the tornado

THE LORAIN, OHIO, TORNADO, JUNE 28, 1924

By HERBERT C. HUNTER

[Weather Bureau, Washington, D. C., August 1, 1924]

Portions of four counties in north-central Ohio were visited on the afternoon of June 28 by the most destructive tornado which that State has known. From the beginning of the path to the end was 52 miles, in direction slightly north of east, but about half the path was over Lake Erie. Different reports of clouds and their movements, as observed, are not accordant, but probably there was but one tornado in the State that day, and it both began and ended over the land.

The first damage seems to have occurred at Vickery, in the northeastern part of Sandusky County, 12 miles west-southwest of Sandusky; here many houses and barns were destroyed or damaged and a few persons were hurt. Farm buildings and trees suffered at Whitmore and Castalia, the places next visited, and at the latter place a boy was killed.

Sandusky, Erie County, is a city of about 23,000 people; the official in charge of the Weather Bureau office there, C. C. Cooper, has furnished a detailed report [13] of the storm, which struck the city at 4:35 p. m. The destruction was practically confined to 9 blocks in the eastern part of the city, where office buildings and factories especially were damaged; on account of the Saturday half-holiday there were very few persons inside, but 3 perished in the wreck of an office building and there were 2 fatalities elsewhere in the city. The damage here was about $1,500,000.

The storm center passed about 1,000 feet north of the Weather Bureau office at approximately 4:35, the barometer falling abruptly by 0.20 inch and within five minutes regaining its former height; the rain, which had been light since it started at 4:15, became heavy and so continued till 8:15, the total fall being 1.41 inches. The wind register indicated the quickest mile at the rate of 77 miles per hour.

The storm passed eastward out over Lake Erie. The displayman at Huron, about 10 miles east-southeast of Sandusky, reports very violent wind and much damage in part of that town, with the possibility that a storm went northeastward through the town and out over the lake to join the greater storm moving eastward from Sandusky.

The displayman at Vermilion, about 9 miles east of Huron, reports a strong gale, shifting gradually from south to west and northwest, as the large black cloud, seemingly a mile and a half in diameter, passed eastward over Lake Erie at a distance of perhaps 4 miles. Heavy rain and lightning prevailed for a long time and fragments of roofing were deposited, but there was no damage of consequence at Vermilion.

About 7 miles west of Lorain and probably a shorter distance about north-northeast of Vermilion, the 95-foot gasoline yacht *Oswichee* encountered the intense storm. The owner, J. A. Williams, of Cleveland, was en route to Put-in-Bay. Dr. M. L. Combes, also of Cleveland, furnished an account of the storm, as the yacht experienced it, to E. H. Emery, in charge of the Weather Bureau office at Cleveland; this is slightly condensed in the following:

> It became evident [about 4:30] that an unusual storm was ahead of us. We saw a very black cloud, one-half mile wide at the water line and much wider at the top. It traveled very fast and was full of lightning, with a peculiar, dirty, yellowish amber glare around it. It was a little north of west and came toward us, traveling southeast. We turned south under full speed until 4:45, at which time a waterspout shot out of it and then down to the water. It was funnel-shaped, base up, and the water seemed to rise to meet it, cone shape. Our barometer dropped to 28.7 just before it struck us. This was about 5:00 p. m. [Three and a half hours before, near Cleveland, the reading had been 29.3 inches. Lake Erie is 572 feet above sea level.]
>
> We turned directly into the wind and storm; there was decided down pressure, and we figured this was the storm descending from the big, dark cloud. The pressure was terrific, but we had passed the center of the storm and were caught half way to the outer edge. The water boiled and seemed to flatten into innumerable whirling or circling eddies, anticlockwise. The fury lasted for 20 minutes, with continuous streak lightning; the roar was so great that we could not hear the thunder. Then the waterspout went across our stern, drenching us with water, followed by a heavy spray and a very decided suction, which lifted the pipe from our furnace as the air rushed up into the vacuum formed. It also pulled up the canvas which covered the top deck and was nailed down around the edges. We were in complete darkness for 20 minutes, followed by a dirty, yellowish, amber glare. * * * The waterspout passed southeast in a direct line to Lorain, and was followed by a terrible rainstorm and high sea. * * * We fought the waves and the high wind, and after two attempts got into Vermilion River at 7:30 p. m.
>
> The *Oswichee* * * * has two 80-horsepower engines and two propellers. When we could not keep her into the wind we would stop one engine and run the other; we did this a number of times; otherwise we would have been lost. * * * Captain Arberts had sailed 50 years on the ocean, and had seen many typhoons; he estimated the wind velocity between 90 and 100 miles an hour.

Lorain, with 37,000 people, in the county of the same name, is divided by Black River, the larger part of the city being west of the river. The chief business street, Broadway, is, for a long distance from the lake shore southward, the first highway west of the river. The time of the tornado, as nearly as can be determined, was 5:08 to 5:11 p. m.

Mr. Emery, after careful inspection and consultations with numerous witnesses, reports that "the storm, coming off the lake from the northwest, entered the city in the vicinity of the municipal bathhouse. Its path varies in width from 4,000 feet to 500 feet, while its length from where it started on land to the place where it lifted is between 3 and 3½ miles." From the bathhouse eastward to beyond the mouth of Black River the northern limit was over the lake. The width of the area of destruction was greatest near Broadway and the river, while east of the river, as the storm went inland, the path contracted considerably in width.

The wreckage at many places clearly indicated rotary winds, and several persons saw the funnel-shaped cloud, although the majority of eyewitnesses failed to recognize it. One of the best statements was secured from Mrs. Hattie C. Hale, who was standing at a window on the third floor of the Opera House Building, and saw the cloud in the northwest.

Mrs. Hale reports that heavy rain had been falling for some time.

> All at once the rain higher up seemed to come in streaks and was being blown very swiftly from the northwest high up in the air, but lower down the trees were all bending toward the north. * * * Then I noticed the perfectly formed, funnel-shaped cloud, with its tail flowing or waving gracefully from it, while the larger part of the cloud was revolving very fast and increasing as it grew nearer.

A large part of the chief business section was laid waste and considerable parts of the residential districts; so that a conservative estimate, made several weeks later

[13] The reports of Messrs. Emery and Cooper, with the statements of the displaymen at Huron and Vermilion and the letter of Dr. Combes to Mr. Emery, also a chart of Lorain and many photographs, are filed in the Weather Bureau archives, where they may be consulted.

put the monetary loss of Lorain at $11,000,000. The loss of life, including the deaths later from injuries, was 73, 8 of these being killed in the bathhouse and 15 in the State Theater. However, 39 names remain on the list of missing at this writing. About 200 were enough injured to need surgical treatment.

Three photographs of the damaged buildings and the wreckage in the streets of Lorain are reproduced; they were obtained through the courtesy of the Cleveland Daily News and the Chicago Herald and Examiner, respectively.

Regarding the effect of the terrific wind on structures, Mr. Emery states:

> There were examples of buildings destroyed and those adjoining receiving little or no damage. Many wrecked buildings had their walls blown in and others their walls blown out. Most of the business blocks wrecked were not of modern construction. The Antlers Hotel, of steel construction, directly in the path of the storm, was not harmed beyond having one corner of its roof damaged.

The tornado settled down again at Sheffield, 5 miles from Lorain, and again at Avon, about 3 miles still farther east, and once more at West Dover, 4 miles beyond. The last-named place is just east of the western limit of Cuyahoga County, but 14 miles from Cleveland. There was damage at each of these places, and press reports state that three deaths occurred at Avon and one at West Dover.

There were high winds over much of Ohio that afternoon and evening, but the information at hand does not clearly indicate any tornado other than the one just outlined. In the northwestern part of Pennsylvania, however, there seems to have been a true tornado near Meadville, in which five lives were lost. The place is so far east of Cuyahoga County, Ohio, and the hour stated (6 p. m.) is so early that this is not considered a reappearance of the Ohio tornado.

Heavy rains, over a period of several hours, marked the weather of northern Ohio that afternoon and evening, and floods sufficient to cause considerable damage occurred in many of the small streams.

The area experiencing high winds in connection with the eastward movement of the LOW extended from the eastern portions of Nebraska and South Dakota, where the strongest winds came at a late hour of the 27th, to west-central New York, where the wind was highest usually after noon of the 29th. There were hailstorms in a few portions of this area, and in portions of Iowa, Illinois, and western Pennsylvania, as well as northern Ohio, some districts had downpours sufficient to cause washouts.

The LOW, which is designated *X* on Chart II of this REVIEW, was central in Nebraska at the evening observation of the 27th, with sea-level reading of 29.52 inches at Valentine; in northeastern Iowa on the morning of the 28th, readings 29.54 inches at Charles City and La Crosse; in lower Michigan the next evening, reading 29.54 inches at Detroit; and near Parry Sound, Ontario, the morning of the 29th, reading 29.36 inches.

The early press reports of the disaster indicated that the losses of life and property at Lorain were so great that the damage greatly and the deaths probably exceeded any previous record of a single tornado; that the damage might equal that at Galveston, Tex., in the hurricane of September, 1900, a storm of quite different type. These early estimates fortunately proved much worse than the truth, though the whole track of the tornado shows 83 deaths and $13,000,000 damage.

Yet $13,000,000 far exceeds the property loss of any tornado for many years back, and, indeed, but two recent years have shown a greater aggregate tornado loss of the whole country during an entire year—1920, with somewhat more than $15,000,000, and 1917, with about $14,500,000. The St. Louis tornado of May 27, 1896, caused damage of about $12,900,000; but the increase which has since occurred in the value of buildings should be remarked.

Regarding great losses of life, the southern tornado in South Carolina, on April 30 of this year, cost 67; no other tornado has killed so many since April 20, 1920, when one in Mississippi and Alabama cost 87. North of the Ohio River no record nearly so great is found since the 103 of the long tornado of May 26, 1917, which was especially destructive at Mattoon and Charleston, Ill. The loss of life in the St. Louis tornado was 306.

THE SOUTHERN MARYLAND WINDSTORM OF JUNE 8, 1924

By B. FRANCIS DASHIELL

On the afternoon of Sunday, June 8, 1924, a windstorm of unprecedented severity passed rapidly over southern Maryland and within a few minutes had caused damage which is conservatively estimated at $650,000. Ordinarily the section referred to is pleasantly free from severe windstorms, and the residents do not recall any storms which even approximate the one of June 8 in such widespread devastation.

The wind, from all appearances, was a straight blow, but a few tornadic effects are indicated at some places. The writer while making a visit to the sections which experienced the storm was unable to obtain any reports as to whether there were clouds having the aspect of a tornado. The wide path in which the storm passed would also indicate a straight blow. Each person interviewed gave a similar report relative to the characteristics of the clouds, and the following description may be said to be a composite description of the cloud appearance before and during the storm. Many people, as well as two Weather Bureau cooperative observers, state that the cloud was the swiftest moving cloud that they had ever observed. Previous to the approach of the storm the sky to the southwest and west took on a yellowish-red lurid glare and was accompanied by a steady roar of thunder, which increased rapidly in intensity as the dark clouds covered the sky. This darkness was not experienced in all localities, but in Washington for a few minutes the darkness was great enough to compel motorists to put on their lights. One cooperative observer stated that the cloud took on the appearance of a flat blanket and rolled at the advancing edge. The red and lurid glare seems to have predominated, as no one who saw the advance of the storm failed to mention this feature. The speed with which the storm advanced may be estimated from the fact that in some cases it was well in progress before windows could be closed.

The wind direction was first southwest and immediately reached a very high velocity, but within a few minutes it suddenly shifted to the northwest and with increased intensity. The velocity can not be estimated,

as there are no stations equipped with the necessary apparatus within the section, but at the central office of the Weather Bureau at Washington, which was considerably out of the path of the storm, a wind velocity of 36 miles was recorded at 3 p. m.

At this same time the barometric pressure was 29.87 inches, which rose rapidly to 29.96 within 15 minutes, but fell to 29.86 inches at 4 p. m.

Within a period of less than 15 minutes the wind had fallen and a perfect calm prevailed, with a clearing sky. The rainfall at three cooperating stations—Cheltenham, La Plata, and Ferry Landing—was 0.38, 0.34, and 0.19 inches, respectively, and during the night there were about 2 inches of additional rainfall. Hail also was quite general over the area, some places east of Washington reporting stones as large as walnuts. A light hail fell in Washington at the beginning of the storm.

In St. Marys and Charles Counties the most destructive wind was from the northwest, while in Prince Georges County the wind was most severe from the southwest. In Calvert County, on the east side of the Patuxent River, the writer found that both the southeast and northwest winds did about equal damage. In some localities large trees were twisted off and scattered in all directions, which would possibly indicate tornadic action; but otherwise the storm as a whole was a straight-line blow.

At Cheltenham an entire piece of virgin forest, consisting of large oaks of several feet in diameter, was completely blown down. At the same place a church was completely moved from its foundations while filled with people. Very few homes were destroyed, most of the damage being confined to porches and roofs, but trees, many of them a century old, around practically every house in the path of the storm were uprooted.

Tobacco barns met with destruction throughout the area, and this is the direct cause of the high monetary losses, as practically every barn was partially filled with cured tobacco awaiting shipment.

In Calvert County there were 64 tobacco barns destroyed, with a loss of over $60,000 for the buildings alone, as no tornado insurance is carried in that part of the East. The loss of cured tobacco will probably amount to $100,000 in this county. In Prince Georges County approximately 80 barns were destroyed, with a loss of over $200,000, while in St. Marys and Charles Counties over 50 barns and contents were destroyed, with a loss of $150,000. The loss of orchards, fruit, stock, fences, timber, etc., will approximate $100,000.

In many cases entire orchards were uprooted, the writer having seen one with the trees blown over in rows with perfect precision. Hundreds of telephone poles were down, and the mass of trees, branches, poles, and wire made public roads impassable for several days. The loss to public-service companies will run into many thousands of dollars.

At Chesapeake Beach, a summer resort on the east side of the bay, in Calvert County, which was crowded with patrons, considerable damage was done by the destruction of cottages, piers, and boardwalk. Falling trees and limbs wrecked a large number of parked automobiles and endangered the lives of the occupants. A number of lives, estimated to be about 10, were lost, mostly when boating parties on the Potomac, Patuxent, and Chesapeake were caught in the storm.

A church, located in a deep valley and surrounded by high wooded hills and filled with colored worshippers, was lifted into the air and dropped some distance from its foundations, demolishing the plastering and windows, while at the same time a horse and buggy standing near the door were blown over a fence into a creek.

One peculiarity of the storm was that the level country bordering the Patuxent River, on the west and east, was singularly free from damage, while the sections back from the river received the entire brunt of the storm. The water on the eastern side of the Patuxent River, which is over one-half mile wide at this point, was backed up so that it overflowed and washed away the surfacing from a road which parallels the river.

At one place the writer noticed a barn which had been blown down by the southwest wind and a scant quarter of a mile off to the east another barn blown down by a northwest wind. A large oak tree was uprooted but a few feet from the door of a public-school house, while smaller trees in the rear of the building were untouched, not even having branches broken off. Reports of streaks of severe wind velocities of this kind were very common.

This storm, covering much of the tobacco belt of southern Maryland, strikes a severe blow to the farmers who raise only tobacco of the famous Maryland type. The loss of over one-half of the great barns in this section will prevent many farmers from growing tobacco this season, as it will be impossible to reconstruct the buildings for the housing of the 1924 crops, which begins with August 1.

RECORD CLOUDBURST FLOOD IN CARTER COUNTY, TENN., JUNE 13, 1924

By WARREN R. KING, District Engineer, U. S. Geological Survey

One of the most terrific rainstorms ever recorded in eastern Tennessee descended upon the small mountain villages of Cardens Bluff, Siam, and Hunter and the surrounding region in Carter County during the night of June 13, 1924. This torrential cloudburst caused the loss of 11 lives, severely injured several persons, and damaged property to the extent of more than half a million dollars. The scene of the disaster lies just east of Elizabethton, along Watauga River, about 20 miles east of Johnson City.

The greatest devastation was wrought in a nearly oval area containing about 50 square miles, the major axis of which extends from northwest to southeast between Hunter and Cardens Bluff. Within this area roads and highways were rendered impassable, many sections being completely washed out and bridges destroyed; houses were swept away; and hundreds of acres of farm land were covered with rock and débris. The mountain division of the Southern Railway, which runs parallel to Watauga River throughout this area, suffered heavy damage. In at least 50 places the track was either swept into the river or was covered with 1 to 5 feet of earth and rock, and many bridges and trestles were washed away. The railroad officials detailed more than 500 men to clear up the wreckage and rebuild the track, and within 6 days after the storm trains were again running on schedule time.

Owing to the comparatively small size of the area covered by the storm, there was no extreme flood on either Watauga River or Doe River, whose channels were more than adequate to carry the flood water, and the bulk of the damage came from floods on small tributaries and from hillside wash.

The storm was caused directly by two extremely heavy rain clouds, one traveling from the northwest, the other from the southwest, meeting almost at a right angle at the same altitude and discharging their load at that point. Either cloud in itself would have produced a heavy rainfall over the area, but, owing to the collision, the condensation of water vapor was extremely rapid. The storm was accompanied by a tremendous display of lightning and deafening thunder.[14]

Those who saw the storm say that not only was there a most intense general rain over the region, but that at many places the clouds broke as if punctured and discharged perfect streams of water. The truth of this statement is shown by deep gashes or scars, almost resembling cuts from a hydraulic jet, that were cut into the hillsides at places where there had been no depression or watercourse. The torrents and landslides that cut these gashes carried everything with them to the foot of the slopes, leaving the underlying rock entirely bare. (See figs. 1–3.)

The region is one of very steep slopes and most of it is heavily timbered. A slide once started gained momentum rapidly and struck with tremendous force. Some single slides carried thousands of tons of rock, earth, trees, and débris down to the lowlands and into the river channel. The hillside scars left by these slides range in width from 10 to 100 feet, and from some points no less than a dozen of them can be seen.

Immediately on learning of the flood the writer, accompanied by P. P. Livingston and D. B. Ventres, of the Chattanooga office of the United States Geological Survey, started for Elizabethton. The party arrived there about 1 p. m. on Sunday, June 15, and collected such information as could be obtained concerning the nature and extent of the storm and the run-off.

Gaging stations are operated by the United States Geological Survey in cooperation with the United States Engineers Corps and the Tennessee Geological Survey at the following points in this region:

South Fork of Holston River at Bluff City, Tenn.
Watauga River at Butler, Tenn.
Watauga River at Elizabethton, Tenn.
Doe River at Valley Forge, Tenn.

Each of these stations was visited as soon as possible, discharge measurements were made by means of current meters, the water surface was marked, and high-water marks were placed in the vicinity. Level lines were afterward run to determine the slope of the water surface at the time of the measurements and the slope of the high-water lines for a length of about 1,000 feet both ways from each gaging station. Complete cross sections were obtained at each gaging station up to the high-water line. Most of the cross sections at the gaging stations were typical of particular stretches of the rivers, and as the streams were still high and no boats were available no other cross sections could be taken. It is believed, however, that for a rough approximation, which is all that was desired, no serious error was introduced because additional cross sections were not taken at other points.

From the discharge measurements and the slope of the water surface at the time, the value of the coefficient n in Kutter's formula was obtained at each point, and from the high-water slope and cross sections, with the value of n thus derived, the crest discharge was computed.

There are three standard rain gages in the vicinity—two owned by the United States Weather Bureau at Bluff City and Elizabethton and one at the plant of the Watauga Power Co. above Siam. The rainfall for the storm recorded at these points was 1.62, 1.00, and 11.24 inches, respectively. At all other points data as to the rainfall and its distribution were obtained by traveling over the storm area and noting the precipitation in tubs, jars, buckets, or other receptacles, that were standing out in the open air in such a position as to catch the normal rain and by making careful inquiry of the residents as to whether these receptacles had contained any water before the storm or whether thay had been disturbed afterwards. All this information was obtained within four days after the storm, during which there had been no more rain. No account was taken of evaporation, which might well have amounted to several hundredths of an inch, as the days had been warm and sultry. Considerable care was taken to get correct data, and check observations were obtained wherever possible. The greatest rainfall was found at Cardens Bluff, where on June 17, three days after the rain, a depth of 14.98 inches was measured in a 20-gallon stone crock standing in an open space 25 feet from a farm house. This crock had been washed and set out in the sun to dry late in the afternoon preceding the storm and had not been molested subsequently.

According to statements of the inhabitants living in the center of the devastated area, the storm began at about 6:30 p. m. in the form of violent hail, which lasted only a few minutes; then a very heavy rain set in, which continued without interruption or abatement until 10 o'clock, approximately three and one-third hours. It then subsided appreciably, although not altogether, until 12:30 a. m., when a second hard rain began that lasted until 2:30 a. m. June 14. By far the greater part of the rain fell during the first storm; in fact, the observations indicate that at least 12 inches of the 15 inches recorded at Cardens Bluff fell during that period of three and one-third hours. At Siam and at the power plant, where the rainfall amounted o about 11 inches, there was no second storm, and this entire amount fell in three and one-half to four hours, as is further indicated by head-water readings taken at the power plant each hour during the night. These readings are given below:

June 13, 1924:	Head-water gage	June 14, 1924:	Head-water gage
6 p. m.	0.1	1 a. m.	3.8
7 p. m.	.1	2 a. m.	3.6
8 p. m.	3.6	3 a. m.	3.3
9 p. m.	4.8	4 a. m.	3.2
10 p. m.	6.0	5 a. m.	3.2
11 p. m.	5.4	6 a. m.	3.2
12 p. m.	4.1	7 a. m.	3.2
		8 a. m.	3.1
		9 a. m.	3.1
		10 a. m.	3.0

It will be noted that the crest of the run-off occurred at this point about 10 o'clock in the evening * * *

A line of levels was run to determine the maximum height of the river above the crest of the Watauga Power Co.'s dam, and it was found to be 6.24 feet. Flash boards 3 feet high, which were on the dam before the storm, failed early in the storm, owing to the immense quantity of heavy drift, leaving only one short section, about 25 feet in length, which was badly damaged. The spillway section of this dam is of the gravity type, with a rounded crest, on which a coefficient of 3.40 was used

[14] Eastern Tennessee on the evening of June 13 was just within a region of unsettled weather with local thunderstorms. The barometer was low generally from the lower Missouri Valley eastward to the Atlantic and there were two areas of still lower pressure within the general area, one over North Carolina, the other over southern Illinois. The winds over North Carolina and eastern Tennessee were light and mostly southerly. The appearance of two clouds meeting may have been more apparent than real. The torrential rain was doubtless the result of violent vertical convection in warm moist air currents that prevailed at the time and place.—*Editor.*

(To face p. 312)

FIG. 1

FIG. 2

FIG. 3

in the Francis weir formula to determine the discharge. It is assumed that the maximum stage of 6.24 feet occurred about 9:45 p. m., the discharge at that time being 12,000 cubic feet per second. It is believed that the flow up to that time came from a point below the mouth of Cobb Creek, which is 9 miles upstream from the dam. The drainage area between the mouth of Cobb Creek and the power dam as measured from the topographic map is 32 square miles, and the run-off was therefore 375 second-feet to the square mile.

The drainage area, including Cobb Creek and everything below Butler, would be 46 square miles, and the maximum rate of run-off would be correspondingly reduced to 261 second-feet to the square mile if Cobb Creek is assumed to have contributed to this peak discharge. It is reasonably certain that the flow above Butler did not enter into this rate of discharge, as it would require an average velocity in Watauga River of 5 feet a second for the flow at Butler to reach the Watauga Power Dam in three hours, and the maximum flow at the dam occurred three hours after the rain began. It seems more than probable that this maximum discharge was derived entirely from the area below Cobb Creek.

The maximum discharge at the dam and other points in this region, as determined by this investigation, is given below.

Stream	Location	Gage height (feet)	Discharge (second-feet)	Drainage area included (square mile)	Run-off (second-feet per square mile)
Watauga	Butler	5.71	6,500	[1] 427	15.2
Watauga	Power dam	6.24	12,000	32	375
Watauga	Elizabethton	13.40	30,000	270	111
Doe	Valley Forge	6.70	5,000	[1] 132	37.9
South Fork of Holston River.	Bluff City	7.25	8,800	[1] 828	10.6

[1] Total drainage area of stream.

An attempt was made to obtain data on the run-off of some of the smaller tributaries that lie wholly within the region of highest rainfall, but on all such streams the slope was so steep and the amount of rock, trees, and other débris carried by the floods so great that nothing resembling an accurate estimate of maximum run-off was possible. All hope of getting any such figures was therefore abandoned. A very striking illustration of this point is the small ravine at Cardens Bluff, where two houses were demolished and nine of the occupants drowned. A careful examination of this ravine indicates that its total catchment area does not exceed 15 acres. One of the inhabitants who escaped stated that a wall of water, rock, and earth 8 to 10 feet in height crashed into these houses without perceptible warning, totally wrecking them. He himself was thrown 30 feet or more by the force of the blow and was severly injured.

The accompanying illustrations (figs. 1, 2, and 3) show something of the force of this record cloudburst and the resulting damage.

No accurate estimate of the damage to property has been made, but the best information available indicates that it was at least half a million dollars.

NOTES, ABSTRACTS, AND REVIEWS

TROPICAL CYCLONES

[Reprinted from Nature, London, June 28, 1924, p. 939]

In his presidential address to the Section of Physics and Mathematics of the Tenth Indian Science Congress, Dr. S. K. Banerji reviewed the present position of our knowledge regarding the origin and causes of tropical cyclones. The contributions to this branch of meteorology of Hann, Lodge, Dines, Bjerknes, and Shaw are considered and none of them found to give a satisfactory explanation of the phenomena. The recent work of Shaw contained in his essay "The Birth and Death of Cyclones" naturally received the most attention.

Doctor Banerji considers that the air currents on the two sides of the "trough of low pressure" which exist over northern India during the monsoon may be the origin of the storms which form at the head of the bay during that season, but he is unable to accept Shaw's explanation of the subsequent development and progress in the development of the theory of cyclones, but considers that many more data, especially from the upper air, are required before much further progress can be made.

LIGHTNING EXPLODES DYNAMITE

Six men were instantly killed at a rock quarry 7 miles south of Winston-Salem, N. C., on June 24, 1924.

The men had sought shelter from a passing electric storm in a temporary office structure in which was stored a quantity of dynamite. Lightning struck a near-by tree and in some manner not clearly understood, exploded the dynamite. The office structure was fired, as were also the inflammable parts of an automobile that was parked near by. The bodies of the men were badly mangled and burned. The explosion was witnessed by persons at a distance.—*News-Observer*, Raleigh, N. C.

WEATHER CONDITIONS IN THE POLAR REGIONS AND AMUNDSEN'S POLAR FLIGHT

[Reprinted from "The Meteorological Magazine," 59, No. 701, June, 1924, p. 1157.]

In the Tidens Tega for March, 1924, there was an account of the weather conditions in the north polar region, written by Doctor Hesselberg in view of Amund-

sen's proposed polar flight. Much valuable information is available from Jan Mayen Island, Bear Island and Spitsbergen, where Norway has permanent meteorological stations, and observations on other islands have been made by the different expeditions to the Arctic; those taken of the *Fram* expedition (1894–1896) form the most complete series and have been used for this article.

Doctor Hesselberg points out that the maximum wind velocity recorded on the *Fram* during any of the months, May, June and July was 15.5 m/s and that therefore the wind conditions do not constitute more of a hindrance than those in our own latitudes. Over the polar seas temperature rises rapidly during May. In June and July the temperature varies but slightly from the freezing point, and it is only the presence of ice which prevents it from rising still higher. Fog, however, is prevalent in the polar regions in the summer and it is this factor, and neither the cold nor the wind, which makes flying so difficult. The fog lies rather low so that there is no difficulty in flying above it, but a forced landing in a sea of fog might easily have fatal consequences. During the winter when the temperature and wind conditions make flying practically impossible there is little or no fog, but it makes its appearance in May and increases in frequency until the middle of July. The longest consecutive periods during which the *Fram* was surrounded with fog were 12 hours in May, 46 hours in June and 71 hours in July.

It is therefore very necessary that Amundsen should make his start as early in the year as possible and that the best measures should be taken to insure him as far as possible from running into unfavourable weather conditions which may occur even at the most favourable period of the year. Weather reports from as many stations as possible within the Arctic circle, from the Norwegian stations at Jan Mayen, Bear Island, Spitzbergen and Vardo, from Nome (Alaska) and from certain stations on the Russian and Siberian Arctic coast, will be sent to him.. Doctor Hesselberg considers that reliance should not be placed on reports from the *Maud*, as there is some doubt as to the capabilities of her wireless outfit.

In justification of such a flight he points out that the weather conditions in the Polar regions have a great influence over the weather of the rest of the globe. A single flight will not provide information of great value, but it will open the way for a regular service of meteorological observations.

BIBLIOGRAPHY

C. FITZHUGH TALMAN, Meteorologist in Charge of Library

RECENT ADDITIONS

The following have been selected from among the titles of books recently received as representing those most likely to be useful to Weather Bureau officials in their meteorological work and studies:

Angenheister, G.

Die luftelektrischen Beobachtungen am Samoa-Observatorium 1914–1918. p. 81–104. figs. 24 cm. (Extr.: Nachrichten der Gesellschaft der Wissenschaften zu Göttingen. Math.-phys. Klasse. 1924.)

Die Wirkung des Regens auf die Registrierung des Potentialgefälles der Atmosphäre. p. 105–115. 24 cm. (Extr.: Nachrichten der Gesellschaft der Wissenschaften zu Göttingen. Math.-phys. Klasse. 1924.

Banerji, S. K.

On the cyclones of the Indian seas and their tracks. p. 49–76. figs. 24½ cm. (Proceedings 10th Indian science congress. Issued Apr. 11, 1924. Presidential address.)

Braak, C.

Het klimaat van Nederlandsch-Indie. v. 1, p. 5. Batavia. 1924. [K. Magnetisch en meteorologisch observatorium te Batavia. Verhandelingen no. 8.] (With English summaries.)

Eredia, Filippo.

Il naufragio del dirigibile "Dixmude" e le depressioni barometriche del Mediterraneo. Roma. 1924. 13 p. figs. 23½ cm. (Extr.: Rivista marittima, Gen., 1924.)

Sull' andamento diurno delle precipitazioni in Roma. Roma. 1924. 14 p. 25½ cm. (Extr.: Memorie e studi idrografici. v. 3, pubbl. n. 2.)

Sulla temperatura del suolo all'osservatorio Etneo. Roma. 1924. 7 p. diagr. 23½ cm. (Extr.: Boll. R. soc. geogr. ital., fasc. 9–12, 1923.)

Hellmann, G.

Untersuchungen über die jährliche Periode der Niederschläge in Europa. p. 122–152. 25½ cm. (Sitzungsber. preuss. Akad. Wissensch. Sitzung phys.-math. Klasse, 27. März, 1924. 11.)

Italy. Servizio idrografico.

Memorie e studi idrografici. Con appendice sulla produzione di energia elettrica nel 1922. Roma. 1924. 258 p. 25½ cm. (Pubbl. n. 2, v. 3.)

Norinder, Harald.

Researches on the height variation of the atmospheric electric potential gradient in the lowest layers of the air. Stockholm. 1921. 96 p. figs. 24 cm. (Inaug. diss.—Upsala.)

Paris. Services techniques d'hygiène.

Météorologie. Paris. 1923. v. 4. 25½ cm. [Re-paged reprint from Annales des Services techniques d'hygiène de la ville de Paris. Compte rendu des travaux de 1913 à 1919.]

Paris. Institut de physique du globe . . .

Annales . . . v. 2. Paris. 1924. plates. 31½ cm.

Poisson, Charles.

Les publications du R. P. Élie Colin . . . Essai bibliographique, 1889–1923. [Tananarive. 1924.] 36 p. 22 cm. [Lists numerous papers on climate and weather of Madagascar.]

Sverdrup, H. U.

Maud-ekspeditionens videnskabelige arbeide 1918–19 og nogen av dets resultater. Skrevet ombord i "Maud" juli 1919. Bergen. 1922. p. 5–88. illus. 23. cm. (Extr.: Naturen, Jan.–Apr. 1922.)

U. S. Weather bureau.

Cloud forms according to the international system of classification. [Washington.] n. d. 22 p. illus. 31 cm. (Prepared by the Weather bureau cloud committee, B. C. Kadel, H. C. Frankenfield, F. G. Tingley.)

RECENT PAPERS BEARING ON METEOROLOGY AND SEISMOLOGY

The following titles have been selected from the contents of the periodicals and serials recently received in the library of the Weather Bureau. The titles selected

are of papers and other communications bearing on meteorology and cognate branches of science. This is not a complete index of all the journals from which it has been compiled. It shows only the articles that appear to the compiler likely to be of particular interest in connection with the work of the Weather Bureau.

American medicine. New York. New ser. v. 19. no. 5. May, 1924.

Melville, E. J. The therapeutic value of sunlight. p. 301–304.

American meteorological society. Bulletin. Worcester, Mass. v. 5. May, 1924.

Choate, H. L. The state of the free-air during the occurrence of general precipitation. p. 72–73. [Abstract.]

Clough, H. W. Some pressure and temperature correlations in the Northern Hemisphere. p. 74–76. [Abstract.]

Fergusson, S. P., & Covert, R. N. The new standard anemometer. p. 67. [Abstract.]

Gregg, W. R., & Van Zandt, J. P. The frequency of winds of different speeds at flying levels between New York and Chicago. p. 69–70. [Abstract.]

Haines, W. C. Ascensional rate of pilot balloons. p. 70–72. [Abstract.]

Jones, J. H. Temperature differences between brick and metal garages. p. 76–77. [Abstract.]

Kimball, Herbert H., & Hand, Irving F. Investigation of the dust content of the atmosphere. p. 67–68. [Abstract.]

Marvin, Charles F. Simplification of the calendar and proposals for promoting the investigation of meteorological data. p. 77–80. [Abstract.]

Tingley, F[ranklin] G. An unusual precipitation-temperature correlation. p. 73–74. [Abstract.]

American society of heating and ventilating engineers. Journal. New York. v. 30. June, 1924.

Ingels, Margaret. Value of the kata thermometer in effective temperature studies. p. 453–454, 560.

Annalen der Hydrographie und maritimen Meteorologie. Berlin. 51. Jahrg. Dezember, 1923.

Baur, Franz. Polarfront und Äquatorialfront. p. 284–287.

Astronomie. Paris. 38. an. Mars 1924.

Balmelle, Marius. La prévision du temps. p. 121–123.

Mariette, Robert. Contribution à l'étude de la variation diurne de la direction du vent. p. 118–121.

Aviation. New York. v. 16. 1924.

Newell, F. B. A special F. A. I. altimeter. p. 590. (June 2.)

Martyrs of science. C. L. Meisinger and Lieut. J. T. Neely. p. 647. (June 16.)

British astronomical association. Journal. London. v. 34. March, 1924.

Stevens, Catharine O. Wind waves and shadow bands. p. 193–194.

Cairo scientific journal. Cairo, Egypt. v. 12. May, 1924.

Watt, R. A. Watson. Atmospherics in wireless telegraphy, their shapes and habits. p. 94–101.

Canadian engineer. Toronto. v. 46. May 27, 1924.

Highland, Scotland G. Weather data at pumping stations. p. 565–566.

Deutsche Seewarte. Aus dem Archiv. Hamburg. 41. Jahrgang, Nr. 3. 1923.

Kuhlbrodt, Erich. Boden- und Höhenwinde der Balkanhalbinsel. Dargestellt in Form von klimatischen Windkarten nach den Beobachtungen an 23 Warten in den Jahren 1916–1918.

Ecology. Brooklyn. v. 5. April, 1924.

Redway, Jacques W. Oscillations of lake levels and changes of climate. p. 150–152.

Shreve, Forrest. Soil temperature as influenced by altitude and slope exposure. p. 128–136.

France. Académie des sciences. Comptes rendus. Paris. t. 178. 1924.

Esclangon, Ernest. Sur les expériences relatives à la propagation du son à l'occasion des prochaines explosions provoquées à la Courtine. p. 764–766. (25 fév.)

Szilard, B. Sur un actinomètre à lecture directe destiné à la mesure de l'ultraviolet solaire. p. 808–810. (25 fév.)

Fournier, F.-E. Sur les tourbillons cycloniques des cirrus ne se propageant pas jusqu'au niveau terrestre. p. 1397–1400. (22 avril.)

Bureau, R. Influence des discontinuités météorologiques sur certaines perturbations atmosphériques en télégraphie sans fil. p. 1623–1625. (12 mai.)

Besson, Louis. Sur la probabilité de la pluie. p. 1743–1745. (19 mai.)

5752—24†——2

France. Académie des sciences. Comptes rendus. Paris. t. 178. 1924—Continued

Dufour, A. Sur la perturbation acoustique, enregistrée à Paris, produite par l'explosion du 15 mai 1924 à la Courtine. p. 1741–1743. (19 mai.)

Mengel, Octave. Rôle des Alpes dans la genèse et la morphologie des tempêtes occidentale. p. 1745–1748. (19 mai.)

Allix, Andre. Sur la prévision des avalanches. p. 1831–1833. (26 mai.)

Baillaud, Jules. Étude sur l'absorption sélective de l'atmosphère à l'Observatoire du Pic du Midi. Anomalies de cette absorption. p. 1834–1836. (26 mai.)

Deslandres, H. Enregistrement de l'onde de la Courtine à Observatoire de Meudon. Deuxième et troisième explosions. p. 1864–1865. (2 juin.)

Esclangon, Ernest. Sur les zones de silence et leur relation avec les caractères météorologiques. p. 1892–1895. (2 juin.)

Franklin institute. Journal. Philadelphia. v. 197. June, 1924.

Humphreys, W[illiam] J[ackson]. The relation of sound velocity to height. p. 821–824.

Geofysiske kommission. Geofysiske publikationer. Kristiania. v. 3, no. 2. 1924.

Röstad, A. Verwendung von Nebelfrostablagerungen um Strömungslinien zu bestimmen.

Geografiska annaler. Stockholm. Årg. 6. H. 1. 1924.

Defant, A. Dis Schwankungen der atmosphärischen Zirkulation uber dem Nordatlantischen Ozean im 25-jährigen Zeitraum 1881–1905. p. 13–41.

Hildebrandsson, H. H. Sur quelques transformations des nuages. p. 1–12.

Wallén, Axel. L'accroissement des conifères et la température. p. 99–100. [Abstract of memoir by G. Kolmodin.]

Wallén, Axel Le débit des fleuves suédois et le rapport de ce débit avec l'eau tombée. p. 42–55.

Geographische Zeitschrift. Leipzig. 30 Jahrg. 2. H. 1924.

Eichelberger, Robert. Regenverteilung, Pflanzendecke und Kulturentwicklung in der ostindischen Inselwelt. p. 103–116.

Hettner, Alfred. Methodische Zeit- und Streitfragen. Die Wege der Klimaforschung. p. 117–120.

Harvard college. Astronomical observatory. Annals. Cambridge, Mass. v. 86. pt. 4. 1924.

McAdie, Alexander. Dry and wet seasons. p. 227–232.

Heating and ventilating magazine. New York. v. 21. June, 1924.

Goldsbury, Paul W. Our artificial winter climate. p. 53–54.

Hemel en dampkring. Den Haag. 22 jaarg. 1924.

Easton, C. De afgeloopen winter 1923–24. p. 147–148. (Mei.)

Kwakkel, H. De invloed van het weer op den mensch. p. 148–152. (Mei.)

Gorczynski, Ladislas. Het registreeren der zonne-straling met de thermo-zuil van Moll. p. 189–194. (Juni.)

van der Bilt, J. Naukeurige meting van dampkringstoestanden. p. 182–189. (Juni.)

Visser, S. W. Halo's in 1923 in Nederlandsch-Indië waargenomen. p. 173–182. (Juni.)

Meteorological magazine. London. v. 59. June, 1924.

Barnes, Alfred A. The great storm of May 31st, 1924. Rainfall at Ludlow, Salop. p. 106–107.

Gold, E. World weather. p. 101–103.

Harries, Hy. Looking along a lightning flash. p. 105–106.

The Meteorological Office exhibit at Wembley. p. 111–112.

S., G. C. Sir Gilbert T. Walker. p. 108. [Apropos of his retirement.]

Weather conditions in the polar regions and Amundsen's polar flight. p. 113.

Nature. London. v. 113. May 31, 1924.

Dines, W. H. Sunshine and health in different lands. p. 784–785.

Fisher, Willard J. The brightness of lunar eclipses. p. 782–783.

Shaw, Napier. Alfred Angot. p. 793–794. [Obituary.]

Petrograd. Institut d'amélioration. Bulletin. Livraison 5. Septembre 1923.

Corosteleff, N. Aperçu climatologique de la vallée de Colchide. p. 69–94.

Scottish geographical magazine. Edinburgh. v. 40. May 15, 1924.

Matthews, H. A. A comparison between the Mediterranean climates of Eurasia and the Americas. p. 150–159.

Wetter. Berlin. 41. Jahrg. Jan./Feb. 1924.

Gautier, F. Karlsruher Wärme- und Kälteextreme. p. 13–17.
Kassner, C. Das Preussische Meteorologische Institut. p. 8–13.
Van Oordt. Die Beziehungen der Klimaforschung zur Heilkunde. p. 17–23
Peppler, A. Von der Badischen Gesellschaft für Wetter und Klimaforschung. p. 29–30.
Ruzicka, Jaroslav. Säkulare Schwankungen der Lufttemperaturen. p. 26–29.
Voights, Heinrich. Moderne Meteorologie im physikalischen Unterricht der höheren Schulen. p. 23–26.

SOLAR OBSERVATIONS

SOLAR AND SKY RADIATION MEASUREMENTS DURING JUNE, 1924

By HERBERT H. KIMBALL, In Charge, Solar Radiation Investigations

For a description of instruments and exposures and an account of the method of obtaining and reducing the measurements, the reader is referred to the REVIEW for January and February, 1924, **53:** 42 and 113.

From Table 1 it is seen that solar radiation intensities averaged close to normal values for June at all three stations.

Table 2 shows that the total solar and sky radiation received on a horizontal surface averaged decidedly below normal at Washington and Madison and close to normal at Lincoln.

Skylight polarization measurements made on three days at Washington give a mean of 38 per cent, with a maximum of 55 per cent on the 26th. Measurements obtained on five days at Madison give a mean of 60 per cent, with a maximum of 71 per cent on the 30th. The values for Washington are below the average June values, and for Madison they are considerably above.

TABLE 1.—*Solar radiation intensities during June, 1924*

[Gram-calories per minute per square centimeter of normal surface]

Washington, D. C.

Date	8a.m.	Sun's zenith distance									Noon
		78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	
	75th mer. time	Air mass									Local mean solar time
		A. M.					P. M.				
	e	5.0	4.0	3.0	2.0	[1]1.0	2.0	3.0	4.0	5.0	e
	mm.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*mm.*
June 5	8.48				0.85		0.97	0.71			7.87
7	9.83		0.53	0.71	0.94	1.26					9.14
15	12.24			0.82		1.30					10.21
20	22.00				0.73	1.16					21.28
24	17.37					1.28					16.20
25	18.59					1.31					19.89
26	11.38					1.35	0.95	0.71			9.83
30	9.47					1.33					8.48
Means			**(0.53)**	**(0.76)**	**0.84**	**1.28**	**(0.96)**	**(0.71)**			
Departures			**−0.08**	**+0.05**	**−0.04**	**+0.08**	**+0.05**	**−0.01**			

[1] Extrapolated.

TABLE 1.—*Solar radiation intensities during June, 1924*—Con.

Madison, Wis.

Date	8a.m.	Sun's zenith distance									Noon
		78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	
	75th mer. time	Air mass									Local mean solar time
		A. M.					P. M.				
	e	5.0	4.0	3.0	2.0	[1]1.0	.0	3.0	4.0	5.0	e
	mm.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*mm.*
June 4	7.29					1.17					7.04
6	6.50			1.06							6.78
10	10.21			0.88	1.06						8.81
14	10.59				0.84						13.13
21	12.24				1.15	1.37					8.81
25	10.21				1.06	1.35					9.14
27	13.61		0.77	0.85							13.13
30	8.18		0.95	1.09	1.23	1.40					10.59
Means			**(0.86)**	**0.97**	**1.07**	**1.32**					
Departures			**−0.01**	**+0.01**	**−0.02**	**+0.01**					

Lincoln, Nebr.

June 4	9.47		0.77	0.94	1.13	1.38					9.83
10	10.21			0.96							9.83
13	15.11					1.31	1.05				16.79
19	14.10			0.70	0.82		1.06	0.75			13.13
20	13.13						1.16	0.88	0.68		13.61
21	12.24			1.04	1.20	1.42					10.59
23	13.13		0.78		1.01						16.20
27	15.11			0.81							19.23
28	13.61						1.08	0.83	0.68	0.58	10.97
30	9.47		0.85	1.01	1.21	1.42					7.87
Means			**0.80**	**0.91**	**1.07**	**1.38**	**1.09**	**0.82**	**(0.68)**	**(0.58)**	
Departures			**+0.05**	**−0.01**	**−0.01**	**+0.03**	**±0.00**	**−0.07**	**−0.08**		

[1] Extrapolated.

TABLE 2.—*Solar and sky radiation received on a horizontal surface*

[Gram-calories per square centimeter of horizontal surface]

Week beginning—	Average daily radiation					Average daily departure from normal		
	Washington	Madison	Lincoln	Chicago	New York	Washington	Madison	Lincoln
	cal.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*
May 28	438	549	503	379	428	−51	+63	−22
June 5	465	411	515	308	433	−31	−87	−27
11	382	390	611	375	368	−111	−121	+56
19	500	404	586	357	411	+6	−121	+9
25	410	497	564			−80	−38	−22
						[1]−1,223	[1]−6,866	[1]+1,977

[1] Excess or deficiency since first of year on July 1.

WEATHER OF NORTH AMERICA AND ADJACENT OCEANS

NORTH ATLANTIC OCEAN

By F. A. YOUNG

The following table shows the average sea-level pressure for the month at a number of selected land stations on the coast and islands of the North Atlantic. The readings are for 8 a. m., 75th meridian time, and the departures are only approximate, as the normals were taken from the Pilot Chart and are based on observations made at Greenwich mean noon, or 7 a. m., 75th meridian time:

Station	Average pressure	Departure
	Inches	*Inches*
St. Johns, Newfoundland	29.82	−0.16
Nantucket	29.94	−0.04
Hatteras	29.98	−0.03
Key West	30.08	+0.08
New Orleans	30.00	+0.03
Swan Island	29.87	±0.00
Turks Island	30.07	+0.06
Bermuda	30.11	+0.01
Horta, Azores	30.30	+0.07
Lerwick, Shetland Islands	29.93	+0.13
Valencia, Ireland	29.98	−0.02
London	30.02	+0.08

Judging from reports received, the number of days on which winds of gale force were reported over the steamer lanes was considerably in excess of the normal as shown on the Pilot Chart. Moderate weather was the rule, however, along the American and European coasts and also in southern waters. The greater part of the heavy weather occurred during the first decade of the month, and conditions during the last 15 days were favorable, with a few exceptions.

Fog was unusually prevalent over the greater part of the ocean north of the 40th parallel, the greatest amount occurring in the 5-degree square between the 40th and 45th parallels and the 65th and 70th meridians, where it was observed on 25 days, while in the two squares immediately adjacent to the eastward and westward it was nearly as frequent. Fog was reported on from 5 to 10 days over the eastern section of the steamer lanes, and on from 2 to 4 days in the vicinity of the British Isles.

On the 1st and 2d there was a depression over Newfoundland, with heavy winds over a limited area in the southerly quadrants. Storm log:

Dutch S. S. *Grootendijk:*

Gale began on the 2d, wind S., 9. Lowest barometer 29.36 inches at 9 p. m. on the 2d, wind SW., 9, in latitude 39° 50′ N., longitude 60° 31′ W. End on the 2d, wind NW., 8. Highest force of wind 9, SW. to NW.; shifts SW.–NNW.

Charts VIII to XI cover the period from the 3d to 6th, inclusive, when an unusually severe disturbance prevailed over an extensive area. Storm logs:

British S. S. *Verentia:*

Gale began on the 4th, wind S. Lowest barometer 29.33 inches at 4 p. m. on the 4th, wind W., in latitude 40° 22′ N., longitude 55° 50′ W. End on the 5th, wind NE. Highest force of wind 9, SW.; shifts S.–SW.–W.–N.–NE.

Danish S. S. *Hellig Olav:*

Gale began on the 4th, wind SE. Lowest barometer 28.55 inches at 11 a. m. on the 4th, wind W., 4, in latitude 50° 37′ N., longitude 37° 13′ W. End on the 5th, wind W. Highest force of wind 9; shifts SE.–S.–SW.–W.

British S. S. *Ashtabula:*

Gale began on the 5th, wind SW. Lowest barometer 29.11 inches at 11 p. m. on the 5th, wind SSE., 8, in latitude 46° 30′ N., longitude 33° 12′ W. End on the 6th, wind WNW. Highest force of wind 9, NW.; shifts SSE.–NW.

This disturbance moved slowly eastward and on the 12th was over the North Sea. Turbulent conditions prevailed generally over the eastern section of the ocean, although the intensity and extent of the storm area varied considerably from day to day, reaching its maximum on the 9th, when moderate to strong westerly and southwesterly gales swept the region east of the 40th meridian, between the 40th and 50th parallels. Storm logs:

American S. S. *Docket:*

Gale began on the 8th, wind S. Lowest barometer 29.67 inches at 3 a. m. on the 8th, wind NW., in latitude 40° 25′ N., longitude 34° 30′ W. End on the 8th, wind WNW. Highest force of wind 11; shifts S.–SW.–W.–NW.–NNW.–WNW.

American S. S. *Independence Hall:*

Gale began on the 9th, wind WSW., 6. Lowest barometer 29.60 inches at 5 p. m. on the 9th, wind WSW., 8, in latitude 46° N., longitude 34° 28′ W. End on the 10th, wind W. Highest force of wind 9, SW.; shifts SW.–WSW.

On the 11th a second depression was over Newfoundland. This moved in a northeasterly direction and on the 13th was central somewhere near latitude 55° N., longitude 35° W. On the 11th and 12th gales were reported from vessels in the region between the 40th and 50th parallels and the 40th and 50th meridians. Storm log:

American S. S. *Hera:*

Gale began on the 11th, wind SW. Lowest barometer 29.40 inches at 1 p. m. on the 11th, wind SW., 8, in latitude 46° N., longitude 42° 10′ W. End on the 12th, wind WNW. Highest force of wind 9, SW.; shifts SW.–W.

On the 14th and 15th high pressure with weak gradients prevailed over the greater part of the ocean although on the latter date there was a shallow depression off the west coast of Florida.

On the 15th a waterspout was observed from the British S. S. *San Gil,* Captain Mathews, Observer J. R. Glen, while en route from Philadelphia to Port Limon. Report follows:

On June 15, 2 p. m., observed waterspout forming, bearing south, distance about ½ mile. Waterspout formed and travelled with the wind, NW., crossing ahead about 500 yards, and disappeared into a heavy rain squall. Position, latitude 18° 34′ N., longitude 75° 23′ W.

On the 16th Halifax, N. S., was near the center of a LOW, while high pressure still prevailed over the central and eastern sections of the ocean, and vessels near latitude 46° N., longitude 25° W., reported moderate northerly gales.

From the 17th to 22d moderate weather prevailed over the ocean as a whole, although a few reports of moderate gales were received from vessels in widely scattered localities.

On the 23d there was a disturbance, limited in area, central about 300 miles south of St. Johns, Newfoundland, with moderate westerly gales in the southerly quadrants. On the same day a second LOW was apparently central in mid-ocean, north of the 50th parallel, although it was impossible to locate it accurately on account of lack of observations.

On the 24th the western disturbance was central near latitude 42° N., longitude 40° W., with northerly to westerly gales over a restric ed area.

From the 25th until the end of the month there ensued another period of inactivity, except that on the 27th and 30th a few vessels encountered moderate gales, as shown by the following storm logs:

British S. S. *Manchester Merchant:*

Gale began on the 26th, wind SW. Lowest barometer 29.94 inches at 10 a. m. on the 27th, wind SW., 8, in latitude 50° 48′ N., longitude 36° 31′ W. End on the 27th, wind WNW. Highest force of wind 8; shifts SW.–WNW.

Japanese S. S. *Yeifuku Maru:*

Gale began on the 29th, wind SSE. Lowest barometer 29.79 nches at 8 a. m. on the 30th, wind WSW., 6, in latitude 44° 45′ N., ongitude 38° 18′ W. End on the 30th, wind WNW. Highest orce of wind 7, WSW.; shifts not given.

NORTH PACIFIC OCEAN

By WILLIS EDWIN HURD

It is axiomatic that "June is a quiet month on the North Pacific." In June, 1924, the axiom held good. As in May, the poor visibility, including cloud and frequent fog along the upper steamship routes, was the principal source of trouble to ocean traffic. The British S. S. *Tascalusa*, Hankow to San Francisco, May 30 to June 17, sailed for the entire period under a sky for the most part thickly overcast, while on seven days the observer reported dense fog.

Fog occurred throughout the month in middle and northern latitudes, being most frequent over a considerable area south and southeast of Dutch Harbor; also between latitudes 40° and 45° N., longitudes 155° and 160° E., along the coast of central and northern California. In the area bounded by 47°–52° N., 164°–169° W., fog was noted on 15 days. Considerable fog also occurred in Asiatic waters and along the coast of Lower California. The American S. S. *Victoria*, from Seattle to Nome and return, reported "fog whenever in ice." She observed ice, while northward bound, near 58° N., 167° W. To quote from her "Daily Journal:"

June 8. Made ice pack at 8.50 p. m.; water, 29°; air, 36°; southerly wind.

June 9. Running around ice pack. Stuck in ice at 8 p. m. to-night.

June 10. Stuck in ice. Heavy pack ice to north and west. Dense fog.

After leaving Nome (18th) much ice encountered until the 21st. All then clear of ice at 35 miles north of Nunivak Island (60° N., 166° W.).

During the early half of June the Pacific anticyclone was unusually well developed, but its center was about ten degrees north-northwest of its normal position, which this month lies at 35° N., 145° W. After the 16th the crest receded to the southward, but remained fairly well developed until the close of the month. No depression disturbed this area from the south, but about the 26th a cyclone entered from the west, centered near 45° N., 145° W. On the succeeding four days it covered the Gulf of Alaska and impinged sharply upon the HIGH to the southward.

Aside from this cyclone, low pressures appeared east of Dutch Harbor only on the 7th and 8th. The remnants of the Aleutian LOW remained usually over the western Aleutian Islands or south of them, being partly energized by the generally shallow cyclones which entered the ocean from Japan.

A LOW originated between Hawaii and Midway Island about the 8th, and from then until the 16th affected somewhat this region and that to the northward, though so far as known without causing strong winds.

At Honolulu conditions were nearly normal. The prevailing wind was from the east. The maximum velocity for a five-minute period was 30 miles from the east on the 26th. This is noted as being as high a velocity as has ever been recorded in June at this station.

Pressure at Dutch Harbor continued below normal, its principal deficiency covering the latter half of the month, as was the case in May. The average pressure, based on p. m. observations, was 29.88 inches, or 0.11 inch below normal. The highest pressure, 30.42, occurred on the 10th; the lowest, 29.26, on the 7th. At Midway Island the negative departure was somewhat less pronounced, being 0.05 inch, the average pressure being 30.02 inches. The highest reading, 30.24, was recorded on the 27th and 30th; the lowest, 29.70, on the 13th. Pressure at Honolulu continued to average close to the normal, which for the p. m. observations is 30.03 inches, the departure being +0.02 inch. The highest reading, 30.14, occurred on the 24th; the lowest, 29.91, on the 9th.

Low pressures prevailed in the Far East, but no record is at hand of a typhoon in these waters.

Off the coast of Central America calms and light winds continued. The one gale—force 8, west-northwest—reported from this region occurred south of the Gulf of Tehuantepec on the 21st.

The cyclone which produced the strongest observed winds of the month lay south of the central Aleutians on the 4th and 5th. The Japanese S. S. *Shidzuoki Maru*, Yokohama to Victoria, encountered on the 4th in latitude 48° 55′ N., longitude 170° 30′ W., very high seas with a gale of force 10 from an easterly direction, lowest pressure 29.35 inches. On the same date the Japanese S. S. *Alabama Maru*, similarly bound, fell in with a northerly gale, force 7, in 48° 31′ N., 176° 32′ E. The weather experienced by this vessel intensified during the 5th and at Greenwich noon, in 48° 41′ N., 178° 40′ W., the wind, continuing from the north, attained force 9, with the pressure at its lowest, 29.14 inches. The American S. S. *West Cajoot*, San Francisco to Dairen, came into the influence of this cyclone on the 4th, but did not encounter rough weather until the 5th and 6th, when northerly gales up to force 9 were experienced near latitude 46° N. and between the meridians about 180° and 172° E.

No other gales of consequence occurred in this region until the 15th, when the Japanese S. S. *Tokiwa Maru*, in 48° 40′ N., 177° 20′ E., experienced a north-northwesterly gale, force 8, lowest pressure 29.20 inches.

Meanwhile, on the 6th, 7th, and 8th, northwesterly gales of force 8 to 9 were encountered by vessels off the coast of California near the 125th meridian, between the 35th and 40th parallels. These occurred where the gradient was sharpest between the great LOW, then occupying the western part of the United States and the oceanic HIGH, then near the crest of its development.

Southerly gales of force 8 were also reported on the 7th and 8th from the region near 50° N., 157° W., along the eastern boundary of a cyclone which was then reaching its strongest development for the month over the region of the eastern Aleutians.

No other gales have been reported thus far for the month, except those that occurred on the 23d to 25th in connection with a cyclone of moderate energy which moved from China on the 19th. On the 23d it left northern Japan, wind E. 7, pressure 29.44, at Nemuro, and

on the following two days was giving southeasterly to northwesterly gales of force 9 near the 40th parallel and between meridians 150° and 160° east. The lowest observed pressure in connection with the disturbance was 29.28 inches recorded on board the British S. S. *Robert Dollar*, in 39° 52′ N., 150° 59′ E., near midnight of the 24th. This cyclone seems to have moved into the Aleutian area and thence into the Gulf of Alaska, where it remained practically stationary during the last three or four days of June.

The following vessels reported waterspouts:

American S. S. *Ensley City:*

June 6, 2 p. m. Passed a waterspout in latitude 11° 43′ N., longitude 90° 30′ W., traveling from SW. to NE. Dark rain clouds overhead.

American S. S. *President Jefferson:*

June 30, 8 a. m. (civil date). In latitude 37° 12′ N., longitude 144° 30′ E., sighted a large waterspout about 400 feet high, lasting about 10 minutes. Wind calm at the time; weather occasionally squally; sea smooth.

SOUTHWEST MONSOON IN ARABIAN SEA; GALES IN SOUTH PACIFIC OCEAN

By ALBERT J. MCCURDY, Jr.

Gales in the Arabian Sea during the period June 9–23 as reported by vessels traversing shipping routes in that region point to a strong development of the southwest monsoon.

During this period the American steamships *William Penn, Anniston* and *Standard Arrow* encountered moderate to fresh gales.

The *William Penn*, Capt. R. H. Wright, proceeding from Singapore toward Karachi, on the 9th encountered a moderate southwesterly gale accompanied by rough seas. Mr. J. E. King, second officer, reports that the lowest pressure observed was 29.71 inches, at 5.37 p. m., in 5° 43′ N., 84° 15′ E. The wind at the time was SW., force 6, later increasing to force 7. Similar conditions prevailed throughout the 10th.

On the 10th the *Anniston City*, Capt. H. Doyle, proceeding from Calcutta to Boston, via Colombo, encountered a southwesterly gale in 6° 31′ N., 86° 10′ E. Mr. W. J. Mullaney, third officer, states that the lowest barometer, 29.55 inches, was recorded at 11 a. m., on the 10th. The wind at this time was W., force 7, later shifting to SW., and increasing to a fresh gale that lasted until noon of the 12th. Almost identical conditions were experienced on the 22d and 23d in 12° 46′ N., 55° 57′ E.

From the 11th to 17th the *Standard Arrow*, Capt. J. C. Harding, proceeding from Calcutta to Port Said, steadily experienced southwesterly winds of force 7 to 8, accompanied by rough seas. The observer, Mr. W. Townsend, reports that the barometer was steady during this period, ranging between 29.72 and 29.82 inches.

The first gale in the South Pacific was associated with a disturbance off the coast of Chili that appeared on June 9 and until the 12th occasioned moderate to whole gales with high seas. The Danzig S. S. *Gedania*, Capt. T. Schroeder, bound for San Pedro from Campana (southern Chili), came within its influence on the 9th. Mr. F. Hesse, third officer, reports that the lowest pressure observed was 29.37 inches (uncorrected), occurring at noon on the 9th in 44° 54′ S., 80° 46′ W. The wind at this time was W. by S., force 10. Rough weather continued through the 11th.

A report of the second gale in the South Pacific was received from the British S. S. *Tahiti*, Capt. R. C. Showman, bound from Sydney to Wellington. The observer, Mr. S. Hodson, states that a fresh gale began at 10 p. m., on the 20th accompanied by frequent heavy rain squalls. The lowest barometer recorded was 30.01 inches, this occurring at 10.42 p. m., in 37° 04′ S., 160° 30′ E. The wind at the time was SSW., force 8. This gale lasted throughout the morning of the 21st and during that time the wind remained steady, blowing from the SSW.

The same vessel again encountered heavy squalls on the 23d, while in the vicinity of New Zealand, reporting conditions similar to those experienced in the previous storm. The lowest pressure was 29.51 inches, occurring on the 24th, in 41° 20′ S., 174° 50′ E. At this time the wind was W., force 7. The gale ended on the 25th. Highest force of wind 8, from SW. by W.

DETAILS OF THE WEATHER IN THE UNITED STATES

GENERAL CONDITIONS

By A. J. HENRY

The cool showery weather of the previous month in northeastern United States continued through the middle of June and even into the third week of the month. On the whole the northeastern districts (east of Rocky Mountains and north of Tennessee) were cool and the remainder of the country was warm. Precipitation was very irregularly distributed, drought in Pacific Coast States and west of the Rockies continuing. The usual details follow.

CYCLONES AND ANTICYCLONES

By W. P. DAY

The low-pressure areas were generally characteristic of the month of June with an increasing frequency of development over the Rocky Mountain and Plateau regions and central interior districts. Three of these LOWS which developed over the Plateau and Rocky Mountain regions became important storms for a day or two and then rapidly declined in intensity.

Of the 10 high-pressure areas which seemed worthy of charting only two were of much importance in their effects. The first, a HIGH of the Hudson Bay type, gave cool easterly winds to the Northeastern States and the Middle Atlantic States from the 9th until about the 13th; while the second, an Alberta HIGH, pushed down from the northwest and slowly overspread middle and northern sections east of the Rockies with abnormally cool weather over these regions from the 29th of June until about the 6th of July.

FREE-AIR SUMMARY

By V. E. JAKL, Meteorologist

The average free-air conditions over the country as determined by kites at the six aerological stations showed throughout the range of altitude covered by the observations, no important departures from normal.

Certain pronounced departures within limited altitudes, however, observed at some stations, were significant in their relation to the surface-weather conditions that prevailed over the regions affected. The month had some unusual features, to which can be attributed the difficulties encountered at a number of stations in obtaining kite observations with the desired regularity. Frequent precipitation at Royal Center and Drexel, and an unusual number of thunderstorms at the latter station, taxed the ingenuity of the station forces to obtain satisfactory flights under safe conditions. At Drexel, contributing to the rainfall of the wettest month in the history of the station, there were 21 days with measurable amounts of precipitation and 19 days with thunderstorms. At Due West light winds handicapped the work, velocities insufficient for launching kites restricting observations by that method to about half the days of the month. At the other stations more favorable conditions for kite observations prevailed. At Broken Arrow, a flight to 6,700 meters on the 3d exceeded all previous records for altitude at that station. In this flight, made in the front of a weak HIGH, the winds were from a general northwesterly direction throughout the air column sounded, the velocities increasing steadily from light on the ground to gale force at the highest point. Humidity diminished gradually from the ground to very dry air at the top, while temperature fell regularly at about the normal lapse rate.

Referring to Table 1, it will be noted that well-marked temperature departures extending to the upper limit of observation occurred only over eastern North Dakota, where the Ellendale record shows that it was uniformly a little colder than normal at all levels observed and at Royal Center to a less degree than at Ellendale. Over other aerological stations, free-air temperatures were generally slightly above normal. Chart III, this REVIEW, showing the surface-temperature departures, may be considered a fair representation of the free-air departures as well, inasmuch as the departures aloft and at the surface did not differ much at any station.

An inspection of the wind resultants (Table 2) shows normal directions and velocities over all stations except Drexel and Ellendale. The wind resultants at all stations for all altitudes are substantially in agreement with the results of pilot-balloon observations, and can therefore be accepted as a true representation of wind conditions for the month, notwithstanding the many interruptions to regular kite observations experienced at some of the stations. At Drexel the winds averaged about southeast in the lower levels up to about 1,250 meters, as compared with normal directions for those levels ranging from south to southwest, while in the upper levels above 2,000 meters, the resultants had a much stronger northwesterly component than normal. Over Ellendale, in the lower levels to 1,000 meters the resultant winds were northerly, or about opposite the normal and diametrically opposed to the winds at corresponding levels at Drexel. In the upper levels above 2,000 meters, the winds were more northerly than normal, and about the same direction as at Drexel.

Opposing winds in the lower levels at Drexel and Ellendale undoubtedly had an important bearing on the abnormal weather conditions prevailing at the former station as regards precipitation and thunderstorms. The surface-wind record at Drexel shows that most of the precipitation at that station was associated with comparatively brief intervals of northerly wind breaking in on the prevalent southeasterlies.

The best example of upper air observations made close to the rain area and hence best illustrating the conditions accompanying this type of precipitation during the month, is afforded by the kite and pilot balloon observations at Ellendale for the 14th. The results are given in the following table, and are apparently typical of conditions that accompanied many of the rain storms at both Drexel and Ellendale.

Meteorological conditions at Ellendale, N. Dak., on June 14, 1924

[Altitude, m. s. l., meters]

WIND DIRECTIONS AND VELOCITIES, M. P. S.

Time	Surface	500	750	1,000
2:07–2:24 p.m.	S.–4	S.–4	S.–5	SSE.–4
9:10–10:24 p.m.	NNE.–4	NNE.–5	NNE.–8	NNE.–9
TEMPERATURE, °C				
9:10–10:24 p.m.	16.9	17.0	17.6	16.4
HUMIDITY, PER CENT				
9:10–10:24 p.m.	94	92	81	70

WIND DIRECTIONS AND VELOCITIES, M. P. S.

Time	1,500	2,000	2,500	3,000	3,400
2:07–2:24 p.m.	SSE.–5	S.–5	SSE.–3	W.–5	W.–9
9:10–10:24 p.m.	NNE.–10	NNE.–11	N.–12	NW.–13	WNW.–19
TEMPERATURE, °C.					
9:10–10:24 p.m.	13.7	10.9	7.5	4.1	1.7
HUMIDITY, PER CENT					
9:10–10:24 p.m.	60	57	57	58	41

Rain began almost immediately after the afternoon pilot-balloon observation, the surface wind simultaneously shifting abruptly from southerly to northerly, accompanied by a sudden drop in temperature. As the balloon observation just preceding the storm shows southerly winds to a considerable height, it is evident that the change to northerly took place first along the ground, gradually extending to the upper levels, until a general condition of northerly winds was attained, as shown by the evening kite observation. Undoubtedly the heaviest precipitation and thunder, recorded in the early part of the storm, were associated with the entering wedge of colder air from the north, while the ending of precipitation indicated that the change in direction had been accomplished from the ground to the prevailing westerlies aloft. The weather maps show indifferent pressure gradients in the vicinity of Ellendale in the morning, changing to gradients north of a well-defined LOW which had developed from the south.

Relative humidities showed no abnormal features, even at the stations where the month was unusually wet. Over Drexel, in fact, the humidity averaged slightly below normal. This apparent discrepancy can be explained by the fact that the precipitation at Drexel on on most days occurred in thundershowers of rather brief duration, and that the kite observations were taken in the intervals of fair weather.

Winds from an easterly direction at high altitudes occurred at a few southern stations during the middle and latter portions of the month, except that at San Juan, P. R., they were of general occurrence at all altitudes throughout the month. In the States, except at Groesbeck and Key West, only single occurrences on scattered dates, are recorded, these being for Broken Arrow, Due West, Memphis and San Francisco. At Groesbeck and Key West, however, they were observed on most days that high observations were possible, from the 10th to the end of the month. When they were not possible, upper clouds were observed moving from an easterly direction. During this period Groesbeck was generally situated southeast of a more or less well-defined trough of low pressure, the easterly winds occurring above winds in the lower levels which conformed roughly to the surface pressure distribution; Key West as a rule was situated within or in the outer fringe of a HIGH lying to the north, northeast or east of the station, and the winds there were generally from an easterly direction at all levels.

It has been found from a statistical study of previous years at Groesbeck that in the summer months there is a strong easterly component in the high-altitude winds above that station. Hence, in connection with the month's record at Key West and San Juan, it may be inferred that a tendency to easterly winds aloft is characteristic of the mid-summer months over the Gulf States. The current month's record at Groesbeck further shows that when this influence is dominating, local disturbances, such as depressions, are effective in overcoming this influence in the lower altitudes only.

Confirming in general the accuracy of these observations, a number of double-theodolite pilot-balloon observations to high altitudes were taken at Groesbeck, one on the 14th extending to the unusually high altitude of nearly 14,000 meters. A double-theodolite observation made at Broken Arrow on the 21st, extended to 13,500 meters, and showed mostly easterly winds to 7,000 meters, and westerly winds above. The computation of all the double-theodolite observations showed an ascensional rate in excellent agreement with the adopted standard, on which single-theodolite work is based.

TABLE 1.—*Free-air temperatures, relative humidities, and vapor pressures during June, 1924*

TEMPERATURE (°C.)

Altitude m. s. l. (m.)	Broken Arrow, Okla. (233 m.)		Drexel, Nebr. (396 m.)		Due West, S. C. (217 m.)		Ellendale, N. Dak. (444 m.)		Groesbeck, Tex. (141 m.)		Royal Center, Ind. (225 m.)	
	Mean	Departure from 6-yr. mean	Mean	Departure from 9-yr. mean	Mean	Departure from 4-yr. mean	Mean	Departure from 7-yr. mean	Mean	Departure from 6-yr. mean	Mean	Departure from 6-yr. mean
Surface	26.1	+1.2	19.7	−1.7	26.4	−0.1	17.5	−2.0	25.8	0.0	21.5	−1.7
250	26.0	+1.2			26.1	0.0			24.7	−0.1	21.1	−1.8
500	24.0	+1.2	19.2	−1.5	23.9	+0.5	17.2	−2.0	22.7	−0.1	18.6	−1.6
750	22.4	+1.2	18.0	−1.2	22.3	+0.7	15.5	−2.1	21.5	+0.2	16.6	−1.6
1,000	21.6	+1.7	17.4	−0.6	20.9	+0.9	13.7	−2.5	21.0	+0.9	15.2	−1.4
1,250	20.9	+2.3	16.7	0.0	19.2	+0.8	11.9	−3.1	20.4	+1.5	13.7	−1.4
1,500	19.9	+2.7	15.7	+0.2	17.4	+0.8	10.2	−3.5	19.7	+2.0	12.4	−1.3
2,000	17.7	+3.4	13.3	+0.6	13.8	+0.5	7.2	−3.6	17.7	+2.4	10.4	−0.7
2,500	14.7	+3.2	11.2	+1.5	10.2	+0.2	4.5	−3.5	15.3	+2.6	7.7	−0.6
3,000	11.2	+2.8	8.8	+2.1	7.5	+0.4	1.6	−3.6	12.5	+2.4		
3,500	7.8	+2.6	7.0	+3.5	4.5	+0.5	−1.3	−3.6	9.6	+2.2		
4,000	4.7	+2.5	4.3	+4.0	1.7	+0.5	−3.3	−2.8	6.2	+1.5		
4,500	1.7	+2.5	1.6	+4.2	−1.0	+0.1	−7.1	−3.4	1.9	+0.2		
5,000	−0.9	+2.5	−1.0	+4.8					−2.4	+0.2		

RELATIVE HUMIDITY (%)

Surface	70	−4	76	+6	66	+3	65	−6	77	+2	74	+10
250	70	−4			66	+3			78	+2	74	+10
500	71	−3	73	+5	66	+1	64	−6	80	+3	73	+8
750	70	−4	68	+3	65	−1	62	−6	77	+1	75	+12
1,000	66	−7	62	−2	65	−1	64	−3	67	−5	74	+11
1,250	60	−11	57	−6	67	+1	66	0	59	−9	77	+13
1,500	55	−14	54	−7	69	+2	68	+4	52	−12	76	+13
2,000	48	−17	54	−4	72	+3	66	+4	42	−15	70	+12
2,500	45	−13	51	−5	70	0	61	+2	39	−14	59	+11
3,000	43	−11	53	−2	61	−4	58	+4	39	−10		
3,500	43	−10	42	−12	57	−5	49	−1	39	−8		
4,000	40	−10	35	−18	54	+1	33	−13	42	−4		
4,500	35	−11	34	−16	52	+7	34	−14	45	−5		
5,000	31	−11	34	−18					47	−5		

VAPOR PRESSURE (mb.)

Surface	23.70	+0.56	17.82	−0.11	22.52	+1.14	13.08	−3.25	25.46	+0.89	19.50	+1.03
250	23.53	+0.60			22.20	+1.15			24.37	+0.75	19.02	+0.82
500	21.34	+0.87	16.61	−0.20	19.67	+0.91	12.71	−3.12	22.00	+0.48	16.07	+0.19
750	19.28	+0.86	14.20	−0.46	17.69	+0.66	11.10	−2.78	19.49	+0.09	14.52	+0.04
1,000	17.05	+0.42	12.60	−0.73	16.18	+0.58	10.16	−2.34	16.16	−0.81	13.20	−0.09
1,250	14.55	−0.20	11.13	−0.94	14.96	+0.69	9.39	−1.87	13.61	−1.29	12.37	+0.18
1,500	12.52	−0.53	9.91	−0.82	13.78	+0.82	8.61	−1.40	11.39	−1.52	11.25	+0.34
2,000	9.37	−0.70	8.59	−0.01	11.29	+0.65	6.68	−1.36	8.17	−1.72	8.71	+0.47
2,500	7.24	−0.14	7.17	+0.32	8.58	+0.05	5.16	−1.30	6.51	−1.36	5.32	−0.13
3,000	5.59	+0.11	6.60	+1.00	6.34	−0.21	3.99	−0.88	5.52	−0.77		
3,500	4.39	+0.06	5.18	+0.69	4.96	−0.05	2.88	−1.01	4.76	−0.41		
4,000	3.44	+0.06	4.07	+0.45	4.00	+0.52	2.06	−1.11	4.16	−0.14		
4,500	2.63	+0.02	3.95	+1.15	3.16	+0.74	1.83	−0.83	3.38	−0.39		
5,000	1.96	+0.02	3.87	+1.49					2.68	−0.39		

TABLE 2.—*Free-air resultant winds (m. p. s.) during June, 1924*

Altitude, m. s. l. (meters)	Broken Arrow, Okla. (233 meters)				Drexel, Nebr. (396 meters)				Due West, S. C. (217 meters)				Ellendale, N. Dak. (444 meters)				Groesbeck, Tex (141 meters)				Royal Center, Ind. (225 meters)			
	Mean		6-year mean		Mean		9-year mean		Mean		4-year mean		Mean		7-year mean		Mean		6-year mean		Mean		6-year mean	
	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.
Surface	S. 5°W.	4.7	S. 4°W.	4.0	S. 47° E.	1.5	S. 1° E.	1.6	N.75°W.	1.6	S. 86°W.	1.0	N. 2°W.	1.1	S. 34° E.	0.2	S. 21°W.	5.0	S. 7° E.	3.2	S. 63°W.	1.1	S. 54°W.	1.2
250	S. 5°W.	4.8	S. 4°W.	4.1					N.78°W.	1.7	S. 84°W.	1.1					S. 20°W.	6.0	S. 6° E.	3.8	S. 60°W.	1.3	S. 53°W.	1.3
500	S. 5°W.	6.2	S. 9°W.	5.4	S. 56° E.	1.8	S. 1° E.	2.2	N.89°W.	2.7	S. 81°W.	1.6	N. 9° E.	0.8	S. 16° E.	0.4	S. 22°W.	7.9	S. 1°W.	5.3	S. 55°W.	1.8	S. 47°W.	2.2
750	S. 13°W.	7.1	S. 14°W.	6.1	S. 58° E.	2.5	S. 10°W.	3.2	S. 85°W.	3.4	S. 75°W.	2.4	N.16°W.	0.4	S. 4°W.	1.1	S. 22°W.	8.6	S. 4°W.	5.7	S. 64°W.	3.6	S. 55°W.	2.9
1,000	S. 23°W.	7.2	S. 21°W.	6.3	S. 61° E.	2.5	S. 25°W.	3.6	S. 87°W.	3.3	S. 77°W.	2.3	N.74°W.	0.5	S. 19°W.	1.5	S. 26°W.	9.1	S. 9°W.	6.2	S. 86°W.	5.3	S. 70°W.	3.6
1,250	S. 36°W.	7.5	S. 26°W.	6.3	S. 23° E.	2.0	S. 37°W.	4.0	N.85°W.	5.1	S. 81°W.	2.9	S. 84°W.	1.0	S. 42°W.	2.0	S. 27°W.	8.4	S. 10°W.	6.4	N.86°W.	5.7	S. 78°W.	4.0
1,500	S. 44°W.	8.1	S. 31°W.	6.4	S. 10°W.	1.9	S. 50°W.	4.4	N.88°W.	6.3	S. 84°W.	3.8	S. 89°W.	1.6	S. 47°W.	2.5	S. 28°W.	7.7	S. 12°W.	5.9	N.87°W.	7.6	S. 85°W.	4.5
2,000	S. 53°W.	7.6	S. 38°W.	6.6	S. 67°W.	3.4	S. 59°W.	5.7	N.80°W.	10.7	S. 89°W.	6.0	S. 85°W.	3.2	S. 59°W.	3.5	S. 26°W.	6.8	S. 13°W.	5.4	S. 84°W.	9.5	S. 84°W.	6.7
2,500	S. 59°W.	8.9	S. 39°W.	6.7	N.76°W.	10.5	S. 71°W.	7.2	N.85°W.	11.7	S. 89°W.	6.3	N.81°W.	6.2	S. 72°W.	5.3	S. 23°W.	6.2	S. 16°W.	5.4	S. 81°W.	10.9	S. 82°W.	8.5
3,000	S. 74°W.	7.7	S. 40°W.	6.4	N.63°W.	14.6	S. 77°W.	8.6	N.80°W.	12.0	W.	7.9	N.86°W.	7.9	S. 80°W.	7.3	S. 29°W.	6.3	S. 18°W.	5.6	S. 63°W.	12.2	S. 85°W.	10.2
3,500	S. 82°W.	7.0	S. 45°W.	7.2	N.64°W.	15.9	S. 79°W.	9.3	N.72°W.	11.9	S. 82°W.	8.4	S. 79°W.	12.4	S. 80°W.	9.1	S. 34°W.	3.3	S. 11°W.	5.7				
4,000	N.77°W.	10.6	S. 54°W.	7.4	N.77°W.	15.5	N.85°W.	8.8	N.68°W.	10.2	S. 82°W.	9.5	S. 76°W.	15.2	W.	11.3	S. 64°W.	5.8	S. 11°W.	6.4				
4,500	N.70°W.	13.6	S. 84°W.	8.0	N.45°W.	16.5	N.75°W.	8.6	N.59°W.	14.7	N.65°W.	13.2	N.66°W.	16.3	N.76°W.	12.9	S. 68°W.	9.5	S. 6° E.	8.3				
5,000	N.56°W.	12.5	N.68°W.	12.4	N.45°W.	16.6	N.51°W.	18.5									S. 68°W.	9.9	S. 68°W.	9.9				

THE WEATHER ELEMENTS

By P. C. DAY, Meteorologist, in Charge of Division

PRESSURE AND WINDS

As was the case during the preceding month, there were frequent cyclonic developments over the interior portions of the country, particularly from the Rocky Mountains to the Ohio Valley, giving much cloudy, rainy weather over the central valleys, although few of these disturbances reached important proportions or maintained their identity for considerable periods of time. Although, as often happens in summer, these cyclonic conditions were not pronounced, they gave rise to frequent local disturbances such as thunderstorms, hail and wind storms and even tornadoes of severe character, and the month as a whole had an unusual number of such storms.

The first cyclone of the month to develop into importance was central on the morning of the 5th over the middle Missouri Valley, extending northward to Manitoba. This moved rapidly northeastward beyond Lake Superior during the following 24 hours, but it was attended by heavy rains in portions of the Mississippi Valley and by severe local storms in Illinois and near-by States.

Immediately following this, cyclonic conditions developed over the Plateau region, and by the morning of the 7th a disturbance of considerable importance was central over the middle Rocky Mountains. As this moved slowly eastward into the central valleys, heavy rains occurred over wide areas, and severe local storms were reported from many sections of the Mississippi Valley and to the eastward. Low pressure, with attendant showers and local heavy storms persisted over much of the Mississippi and Ohio Valleys and to the eastward until about the middle of the month. On the morning of the 17th unsettled weather had again overspread the western mountains and Great Plains, and heavy rains with local severe storms prevailed during the following 24 to 48 hours from the Mississippi Valley northward to the Dakotas and into the adjacent portions of Canada, the storm having been forced far to the northward on account of anticyclonic conditions existing over the upper Lakes.

Unusually heavy and widespread rains occurred during the first half of the last decade over many sections from the Great Plains eastward, although there were no important cyclonic developments until toward the end of the period.

Toward the latter part of the month pressure diminished over the central valleys, and by the morning of the 28th a fairly well-defined low-pressure area was central over the upper Mississippi Valley. During the following 24 hours this depression moved over the Great Lakes region into the St. Lawrence Valley, attended over portions of northern Ohio during the afternoon of the 28th by one of the severest tornadoes of recent years, a full account of which will be found elsewhere in this issue.

Anticyclones were mainly weak and confined principally to the more northern localities. Those materially affecting the weather occurred during the early part of the second decade, when a HIGH of the Hudson Bay type overspread the more eastern States, giving cool northeasterly winds to those regions; and again near the end of the month an anticyclone moved from western Canada into the Missouri Valley, giving moderately cool weather at the end over most districts.

The distribution of the atmospheric pressure during the month had no pronounced tendency, further than toward lower than normal averages over the central and eastern districts, and to somewhat higher than normal averages over the northwestern and far western districts. Average pressures were higher than during the preceding month from the Mississippi Valley eastward, and mainly lower to the westward.

Despite the fact that barometric changes were mainly slight and the gradients usually shallow, local high winds were frequent and often associated with hail, causing wide damage to crops and injury to trees, buildings, etc. A list of the more important storms of the month follows at the end of this section.

TEMPERATURE

At the beginning of the month temperatures remained below normal from the Great Plains eastward, as had been the case during the preceding month, while west of the Rocky Mountains warm weather continued, though there was some relief from the severe heat experienced during much of the preceding month.

The seven-day period, the 3d to 10th, continued cold over most central and all northern districts, the temperature averages for the week ranging mainly from 6° to 12° below the normal. In the more southern States, however, a change to conditions more nearly normal with regard to temperature had set in and the week as a whole was moderately warmer than normal.

The week following the 10th brought a marked rise in temperature over most northwestern districts during the

early portion, but it still continued unseasonably cold in the northeastern States. The week as a whole was moderately warm in all portions save from the Great Lakes northeastward to New England and southeastward to the Carolinas, where temperatures still continued below the seasonal normal, and over interior California where moderate temperatures were a welcome relief from the excessive heat that had persisted for a number of weeks.

The week ended June 24 was the first over a long period with average temperature above the normal over all eastern districts, and it was decidedly warm during the early part over the Southwest, where high temperatures had persisted for a considerable period. From the Dakotas westward to the Pacific and generally over the Plateau region this week was moderately cool.

The last week of the month continued warm over most southern and all far western districts, the temperatures continuing high over the southern Plains. The week was moderately cool, however, over nearly all central and northern districts, and distinctly cool over the central districts at the close.

The warm periods of the month were mainly during the latter half, generally near the end of the second decade over the districts from the middle and southern Rocky Mountains eastward, and near the close of the month from the Dakotas westward and southwestward to the Pacific coast.

Over portions of New Mexico and adjacent States excessive heat was almost continuous from the beginning of the second decade until near the close of the month, probably the longest period of intense heat ever known in that district. At points in Nevada, Idaho, and Washington the maximum temperatures on the 30th were the highest of record for June.

The lowest temperatures of the month were mainly during the first week from the Great Plains eastward and near the middle of the month in some of the Plateau and Pacific Coast States. Freezing temperatures were reported at some period during the month from exposed points in all the northern tier of States and generally at the high elevations of all the Western Mountain States. A minimum temperature of 26° was reported from Pennsylvania, 24° from Wisconsin, 28° from South Dakota, and as low as 14° in Colorado.

For the month as a whole the average temperature was mainly below normal from the central and northern Rocky Mountains eastward to the Atlantic coast, the greatest departures, ranging from 3° to 4°, occurring from central Montana and northern Wyoming eastward to the Great Lakes, northern New York, and the interior of New England. The month was mainly warmer than normal over southern and western districts, the excesses being large from the Southern Plains westward to Arizona and eastern California. At a few points the month was unusually warm, notably at Tampa, Fla., and Roswell, N. Mex., where it was the warmest June of record.

PRECIPITATION

Over the great central and southern districts there were many sharp variations in the amounts of precipitation received during the month. In portions of the Missouri and middle Mississippi Valleys and adjacent areas precipitation was frequent and the total falls far above normal. On the other hand, near-by areas in Kansas, the southern drainage area of the Ohio, and localities in the Great Lakes region had far less than the normal fall. Similar conditions existed in the Southern States, where in the coast districts of Texas the falls were in some cases the greatest of record for June, while other portions of the State, as well as near-by areas of adjacent States, suffered greatly from drought.

In the far West drought continued, and the general lack of moisture for the season to date, associated with high temperatures that have prevailed for many weeks, has produced a serious water shortage in many sections. The early melting of the slight snow cover in the mountains of California and the adjacent portions of Nevada and Oregon has reduced the flow of the rivers and streams to the lowest stages ever known. The long drought has greatly depleted the reserve of underground water and it is becoming increasingly difficult to secure necessary supplies even from that source.

On account of the prolonged drought, forest fires increased in these and other western districts and have been controlled only with great difficulty. In Arizona, New Mexico, and other portions of the Southwest, where the rainy season usually begins in June, rains were delayed very generally until near the end of the month, and these were usually light, except in portions of Arizona, where moderate falls occurred locally. In Colorado the month was the driest of record for June.

Some good rains occurred in the Dakotas and most other portions of the eastern spring-wheat region, but it continued dry in the far Northwest, where precipitation has been deficient for many months.

SNOWFALL

Unusually heavy snow, for so late in the season, occurred over northwestern Montana on the 7th, falling to depths up to 14 inches and causing much damage to trees. At Kalispell a depth of 9 inches was measured, being the greatest depth of snow ever recorded at that station in any month of the year save one.

Due to the continued high temperatures, snow in the mountains of California decreased rapidly and disappeared entirely from peaks that had not been free from snow so early in the season within the memory of the oldest inhabitants.

RELATIVE HUMIDITY

The frequent and locally excessive precipitation and generally cloudy weather over much of the Missouri, upper Mississippi, and Ohio Valleys, and eastern districts indicate an unusually moist condition of the atmosphere and this is shown by the monthly percentages of relative humidity which were in many sections of these areas far above normal. On the other hand, the percentages over nearly all far western districts, where drought has existed for long periods were nearly everywhere greatly deficient.

SEVERE LOCAL HAIL AND WIND STORMS, JUNE, 1924

[The table herewith contains such data as have been received concerning severe local storms that occurred during the month. A more complete statement will appear in the Annual Report of the Chief of Bureau]

Place	Date	Time	Width of path (yards)	Loss of life	Value of property destroyed	Character of storm	Remarks	Authority
Stafford, Pawnee, and Pratt Counties, Kans.	1	5-6 p.m.	3-6 miles		$200,000	Hail	Thousands of acres of growing crops destroyed; buildings damaged. Amount of damage in Pratt County not known.	Official, U. S. Weather Bureau.
Atlanta, Ga.	1				5,000	Wind, rain, and hail.	Considerable damage in parts of city	Do.
Tyrone, Okla.	4		2 miles		4,000	Hail	Character of damage not reported	Do.
Edwards County, Ill. (southern part of).	4		8 miles		1,000	Heavy hail	Some crop loss; windows and roofing damaged.	Do.
West Point, Iowa	5	4 p. m.	1.5 miles		25,000	Hail	Considerable crop damage and some poultry killed.	Do.
Amarillo, Tex.	5					Heavy hail	Roofs and crops damaged	Do.
East of Milmine to beyond Bement, Ill.	5	P. m.	80-130		5,000	Tornado	Some property damage. Path 6 miles long.	Do.
Christian and Shelby Counties, Ill.	5	6 p. m.		1	14,000	Wind	Extensive property damage; 3 persons injured.	Do.
Pottawatomie County, Okla.	5	2 a. m. and 8 p. m.	1-3 miles		7,000	Hail	Dwellings and crops damaged	Do.
Palo Verde to Mosquero, N. Mex.	5	2-3 p. m.	1-3 miles		30,000	Heavy hail	Character of damage not reported	Do.
Shelby, Marion, Ralls, and Pike Counties, Mo.	5	11:30 a. m. to 1 p. m.	4 miles		103,000	Hail	Extensive destruction of crops. Minor property loss.	Do.
Chatham, Ill. (southwest of).	5				20,000	do	Some crop loss	Do.
From LaHarpe (near) diagonally across McDonough County to Astoria, Ill.	5	4 p. m.	3 miles		58,500	Wind and hail	Wheat in head entirely destroyed; other crops suffered severely. Roofs and windows damaged. Path 40 miles long.	Do.
Hancock County, Ill. (northwest part of).	5	3-5 p. m.			80,000	Hail	Heavy property loss	Do.
Terre Haute, Ind., and vicinity.	5-6					Thunderstorm	Damage principally to public utilities	Do.
Covington, Okla.	6	3 p. m.			25,000	Wind	Considerable property damage	Do.
Richmond, Va.	6	8:30 p. m.				Wind and rain	Buildings and trees damaged	Do.
Brown County, Kans.	7	5 p. m.				Tornado	Property damage reported comparatively small.	Do.
Le Roy (near), Kans.	7-8	11 p. m. of 7th to a. m. of 8th.	1 mile		10,000	Wind	Extensive damage reported	Do.
Boos, Ill. (vicinity of)	8		2 miles		5,000	Hail	Young chickens killed and buildings damaged	Do.
Baltimore and southern-eastern shore counties, Maryland.	8	P. m.			650,000	Wind and rain	Trees uprooted, tobacco barns demolished, and much property destroyed.	Do.
East-central, Ind.	8	A. m.		1	1,000,000	Violent wind	Extensive property and crop loss. Several persons injured.	Do.
Cheyenne, Wyo.	8		3 miles		3,500	Heavy hail	Damage to vegetable and flower gardens. Path 7 miles long.	Do.
Caney to Hallowell, Kans.	9	5-6:30 p.m.		1		Tornado	Considerable damage to small buildings, poles, and wires.	Do.
Meno, Okla.	9				12,000	Heavy hail	Roofs riddled and some stock killed. Stones, 18 to 24 inches in circumference.	Do.
Perry and Marland, Okla.	9				10,000	Wind	About $5,000 property loss in each place	Do.
Brown County, Nebr.	11	6 p. m.	450			Small tornado	House and a number of farm buildings wrecked.	Do.
Custer, Sherman, Kearney, and Polk Counties, Nebr.	11		0.5-2 miles.			Hail	Crops injured	Do.
Mayes County, Okla. (northeast part of).	11	3-6 p. m.	2-4 miles		208,500	Heavy hail	Much destruction of property and crops	Do.
Concordia, Kans. (south and east of).	11	P. m.				do	Fruit and small grains injured; some poultry killed.	Do.
Muscatine, Iowa.	12	4 a. m.			20,000	Hail	Character of damage not reported	Do.
Milwaukee, Wis.	12	4:15 p. m.			38,800	Hail, wind, and rain.	Windows broken, greenhouses wrecked, awnings, signs, and trees torn by wind. Some damage by flooding.	Do.
Missouri (northwest part of).	12	5-5:40 a.m.			130,000	Thunderstorm	Extensive damage to crops and property over five counties. About 700 square miles involved.	Do.
Galesburg, Ill., and vicinity.	12	5-6 a. m.	3 miles		825,000	Wind and hail	Property and crops suffer heavy damage; many fine shade trees destroyed. Path about 14 miles long.	Do.
Rock Island, Mercer and Warren Counties, Ill.	13	5:30-7 p.m.				do	Much destruction to property in general and crops.	Do.
Scott County, Iowa.	13	P. m.			500,000	Hail	Grains, fruit, and window glass ruined	Do.
Winnebago County, Iowa.	13	3 a. m.	880		8,000	do	Considerable crop destruction and minor damage to buildings.	Do.
Davenport, Iowa.	13					Thunderstorm	Some property damaged in city and small buildings and crops in outlying districts hurt.	Do.
Anne Arundel County, Md. (northeast part of).	13	3-4 p. m.	1-6 miles		98,000	Heavy hail	Heavy property and crop damage. Storm was most severe in neighborhood of Jones Station.	Do.
Waverly and Williamstown into Richie County, W. Va.	13	12:30 to 1:15 p. m.	2 miles		8,000	do	Roofs and windows damaged; crops injured. Greatest damage near Petroleum.	Do.
Blandville, Ky.	13	9:15-10:10 p. m.	880			Wind and hail	A number of barns blown down; stock killed, trees prostrated, crops damaged.	Do.
Brownsville, Ga. (2 miles east of).	14	3:30-4 p.m.	2 miles		50,000	Hail	Extensive crop damage	Do.
Wayne County, Nebr.	14	9 p. m.				Small tornado	A few buildings unroofed, small buildings blown down, trees uprooted and broken.	Do.
Southern Iredell and northern Mecklenburg Counties, N. C.	14		1-4 miles		250,000	Heavy hail	Very heavy crop damage. Crops completely destroyed in places Path 30 miles in length.	Do.
Central and eastern South Dakota.	14	4-8:30 p.m.		7	2,750,000	Thunderstorm and wind.	Severe property and crop destruction; 80 persons injured; stock and poultry killed. Greatest damage in Jerauld County.	Do.
Osceola County in the northwest to Appenoose County in south-central Iowa.	14					Winds	Numerous trees uprooted or torn, farm buildings, windmills and silos blown down and crops badly damaged. More than $100,000 damage.	Do.
Chattanooga, Tenn.	15					Wind and rain	Streets flooded, trees and wires down	Do.
Cascade County, Mont. (northern part of).	15					Tornado	Buildings in path demolished, a number of people injured, and grain damaged.	Do.
Mobile, Ala.	16				5,500	Thunderstorm	Minor damage reported	Do.
Glasgow, Mo. (vicinity of)	17					Wind	Severe damage to roofs and trees over a narrow path.	Do.
Dickinson, N. Dak., and vicinity.	18	P. m.		6		Severe wind with hail.	Buildings of all types, also trees, damaged or destroyed.; crops greatly injured.	Do.
Washington County, Ill.	18	2 a. m.			25,000	Hail	Wheat, oats, and corn totally destroyed over about 2,600 acres.	Do.
Benton and Carrier Mills, Ill., and adjacent districts.	18				33,000	Wind and hail	Trees uprooted, windows broken, small outhouses destroyed, and considerable crop loss; one man injured.	Do

SEVERE LOCAL HAIL AND WIND STORMS, JUNE, 1924—Continued

Place	Date	Time	Width of path (yards)	Loss of life	Value of property destroyed	Character of storm	Remarks	Authority
Between Arendtsville and Brysonia, Pa.	18	2-3 p. m.				Heavy hail	Half of apple crop destroyed and other crops damaged severely.	Official, U. S. Weather Bureau.
Bismarck, N. Dak.	18			2	100,000	Wind, hail, and electrical.	Property destruction extensive	Do.
Venango, Pa., and vicinity	20	11-12 p. m.	880		7,000	Wind	General damage done, considerable in Erie County.	Do.
Evansville, Ind.	20	4:10 - 4:30 p. m.				Thunderstorm	Electric light, telephone, and telegraph wires damaged to some extent; plate glass window broken and other minor damage.	Do.
Pella, Iowa	20	P. m.	4 miles			Hail	Crops and fruit injured	Do.
16 counties in Illinois., principal group in north and northwest.	20			4	165,000	Wind and hail	Much destruction of property and crops; transportation delayed; 5 persons injured.	Do.
Arma, Kans.	20	1 p. m.				Tornado	One home destroyed	Do.
Lansing, Mich.	20	4:31 - 4:50 p. m.			50,000	Hail and wind	Much property and considerable crop damage	Do.
Port Huron, Mich., and vicinity.	20	P. m.		1	11,500	Thunderstorm	Wire communications cut off, limbs torn from trees, farm buildings damaged.	Do.
Racine County, Wis.	20	7:30 a. m.	300-3,520		500,000	Tornado	Buildings, wires, and trees wrecked or damaged; 12 persons hurt. Path 30 miles long.	Do
Erie, Pa., and vicinity	20-21					High winds	Slight damage in city, heavy in outlying districts.	Do.
Southern part of Iowa County and northern part of Keokuk County, Iowa.	20-21					Hail	All crops practically a total loss	Do.
Dunkirk, N. Y., and vicinity	20-21	11:55 p. m.-12:20 a. m.				Thunderstorm	Building uproofed, trees uprooted or broken, wires down; grape crop much reduced.	Do.
Buffalo, N. Y., and vicinity	21				300,000	Thunderstorm	Heavy damage in city and considerable destruction in outlying sections. Some damage by wind in Rochester on same date.	Do.
Cape Henry, Va., and adjacent coast.	21	8:01-9 p. m.				Thunderstorm, wind, and rain.	Cottages and other buildings along coast between Cape Henry and Virginia Beach damaged; one consumed by fire started by lightning. Truck gardens injured.	Do.
Hamilton County, Kans. (southwest part of).	21	5 p. m.	2 miles		3,000	Hail	Garden, fruit, and other growing vegetation destroyed.	Do.
Clay County, Nebr.	22	5-6 p. m.	4 miles			do	Wheat and other crops damaged in places 40 per cent. Many window panes broken.	Do.
Lincoln, Lyon, Redwood Counties, Minn. (southern part of).	22	P. m.		3	500,000	Tornado	Heavy losses sustained by farmers	Do.
Drexel, Nebr.	22	P. m.				Thunderstorm	Trees, telephone and telegraph lines broken, and some damage to power lines.	Do.
Chicago, Ill.	22	3:25 p. m.		3		Wind and rain	Telephone, telegraph, and power companies suffer greatest loss. Basements flooded and a few buildings damaged.	Do.
Terrell County, Ga.	23	4:30 p. m.	1 mile		10,000	Heavy hail	Heavy crop damage	Do.
Elliott (near), S. C.	23			2	40,000	Tornado and hail	32 persons made homeless; heavy property and crop damage. Path of hail about one-half mile wide.	Do.
Lowryville, S. C.	23	5:30 p. m.	880		3,000	Hail	Character of damage not reported. Short path	Do.
Prospect region near Louisville, Ky.	23				10,000	Wind	Character of damage not reported	Do.
Wathena (near), Kans., to Clarksdale, Mo.	24	5 p. m.	100		65,000	2 tornadoes	Slight damage in Kansas but much heavier in Missouri; 3 persons injured. Path, 25 miles.	Do.
Ford County, Ill.	24	P. m.			90,000	Wind	About 200 buildings, mostly farm properties, were destroyed, and poles and wires were blown down.	Do.
McDonough County, Ill.	24	P. m.			100,000	do	Rural property damaged; 5 persons injured	Do.
Sunbury, Pa.	25	12:50-2:30 p. m.	5 miles		201,000	High winds	Heavy property destruction but crop damage relatively small.	Do.
Oxford and parts of Chester County, Pa.	25	3-4 p. m.	880-1,320		275,000	Heavy hail	Extremely heavy property and crop damage; amount outside of Oxford not known.	Do.
Wilmington, Del.	25	3:30 p. m.		2	1,000,000	Wind	250 buildings damaged; 400 trees destroyed; other minor damage; 9 persons injured.	Do.
Otoe County, Nebr.	26	5 a. m.	2-3 miles		10,000	Heavy hail	Crops total loss in places	Do.
Kansas City, Mo.	26	11:45 p. m.			10,000	Hail	Damage principally to window panes and greenhouses.	Do.
Sundance, Wyo. (8 miles north of.)	27	3 p. m.	4 miles			Wind	150 acres of forest destroyed; minor property damage, and some livestock killed.	Do.
Omaha, Nebr.	28	A. m.				do	Telephone, telegraph, and power lines down.	Press Dakotan (Yankton, S. Dak.).
Sigourney, Iowa	28	12:01 a. m.			800,000	Hail and wind	All crops, especially small grains, severely damaged; many windows broken.	Official, U. S. Weather Bureau.
Iowa	27-28					Wind and hail	Enormous damage throughout the State, especially over a strip 75 miles in width running east and west across the center of the State; all wire systems paralyzed, 1,000 buildings damaged, car service suspended, communication cut off.	Do.
Peoria and Tazewell Counties, Ill., westward to Mississippi River.	28	3-4 a. m.		4		Wind and rain	Houses unroofed, substantial farm buildings wrecked, orchards leveled, wires down, and some washouts; total damage thought to be more than half a million dollars in Peoria and Tazewell Counties alone.	Do.
Sandusky and Lorain, Ohio [1]	28	4-6 p. m.	167-1,333	83	13,000,000	Tornado	Hundreds injured; one quarter of the buildings in Lorain wrecked or damaged.[1]	Official, U. S. Weather Bureau; Plain Dealer (Cleveland, Ohio; Times (Toledo, Ohio).
Northern Ohio	28	P. m.		4		Wind, rain, and hail.	Much wind damage outside the tornado track; considerable flood damage; 3 killed at Mantua; 1 killed at Akron.	Do.
Meadville, Pa., and vicinity	28	P. m.		5	500,000	Tornado	Much loss of property	Official, U. S. Weather Bureau.
North Braddock, Pa.	28	P. m.		2		Wind	House blown over	Times (New York).
Erie (near), Pa.	28	P. m.				do	Many houses wrecked, chiefly at Lawrence Park	Official, U. S. Weather Bureau.
Western Pennsylvania	28-29	During night.				Wind and hail	Several towns suffer property damage	Times (New York).
Rochester, N. Y.	29	P. m.				Wind	Windows broken, roofs damaged, wires and awnings down, trees injured.	Official, U S. Weather Bureau; Democrat and Chronicle (Rochester, N. Y.).
Due West, S. C.	30	P. m.	1.5 miles			Thunderstorm and hail.	Cotton and corn crops injured; melons slightly damaged.	Official, U. S. Weather Bureau.

[1] For a detailed description of this tornado see pp. 309-310 of this REVIEW.

STORMS AND WEATHER WARNINGS

WASHINGTON FORECAST DISTRICT

Few disturbances crossed the country during June and those that did were of slight or moderate intensity. Consequently no storm or small-craft warnings were issued for the Atlantic and east Gulf coasts.

Advisory warnings were issued, however, during the 20th–22d in connection with a tropical disturbance of slight intensity that moved inland over Mexico in the vicinity of Tampico. Pressure fell gradually over the northwestern Caribbean Sea during the 15th–17th, the decrease in that time amounting to 0.14 inch at Tela, Spanish Honduras, and Belize, British Honduras, and 0.04 inch at Swan Island. A further slight decrease took place at these stations on the 18th. By the 19th this decrease in pressure had reached the southwestern portion of the Gulf of Mexico and on the morning of the 20th Tampico, Mexico, reported a barometer reading of 29.68 inches and Brownsville, Tex., 29.74 inches. Rain set in along the Texas coast during the night of the 19th–20th, and excessive rainfall occurred at Brownsville and Corpus Christi on the 21st. The disturbance was moving slowly west-northwestward across the Bay of Campeche during this period and it moved inland during the 21st–22d. Heavy rains occurred at several Mexican stations. No strong winds were reported in connection with the disturbance.

No frost warnings were issued, except for the interior of northern New England on the 9th, and for the cranberry bogs of New Jersey on the 4th, 5th, 7th, and 9th.—*Charles L. Mitchell.*

CHICAGO FORECAST DISTRICT

The month was marked by rapid movement of storm areas across the region, with frequent rains, except in the extreme western portion, and with changeable temperature which averaged, on the whole, considerably below the normal, except in the Far Southwest. The frequency of storms and lack of sunshine prevented the temperature from maintaining high maxima, except for brief periods. The month was, therefore, abnormal, in point of rainfall and coolness.

However, except for a few local squalls, no storm caused winds of a marked character on the Great Lakes until toward the close of the month. A disturbance which developed in the Far West was centered on the morning of June 28 in Iowa. This storm moved northeastward to Ontario and the St. Lawrence Valley directly across the Great Lakes, and was attended by fresh to strong winds, severe squalls, and tornadoes from the Middle Mississippi Valley eastward over the Lake Erie district. Small-craft warnings were ordered for all Lake stations on the morning of the 28th, with advice that the winds would be fresh and strong and accompanied by squalls. On the morning of the 29th northwest warnings were ordered hoisted on Lakes Erie, Ontario, and southern Huron.

Frost warnings were issued on the 7th and 9th for localities in the Northwest and at various times during the month for the cranberry marshes in Wisconsin. The season in the marshes was unusually late, preventing the vines from developing normal growth.

Special forecasts were issued daily in the interests of the fruit growers of Door County, Wisconsin, and of southwestern Lower Michigan.

Fire-weather forecasts were forwarded daily to the Forest Service officials in western Montana.

A special forecast was made for southeastern Lower Michigan on June 22d, in connection with the aerial fox and hounds race conducted by the Detroit Free Press. It served its purpose, as shown by the following statement from Mr. Norman B. Conger, meteorologist, Detroit, Mich.:

> The winds from the southwest prevailed during the time of the flight, as forecast.
>
> Mr. Ralph Upson, who had charge of the balloon flights, and the Free Press force, were enthusiastic in their thanks for the information furnished.
>
> —*H. J. Cox.*

NEW ORLEANS FORECAST DISTRICT

After the 10th, dry, hot weather prevailed in much of the district; but this condition was broken by showers and cooler weather for a few days at the beginning of the last decade and again at the close of the month. Areas or troughs of low pressure, moving east or northeast, were generally shallow and most of them were attended by little or no precipitation in the district.

On the 20th–21st, during the moderate disturbance in the Gulf east of Tampico, Mexico, described under Washington Forecast District, winds on the Texas coast blew rather persistently from the southeast and were stronger than at other times during the month, partaking somewhat of the character of moderate thundersqualls. Small-craft warnings were displayed on the 21st in the Corpus Christi district by the Weather Bureau official at that place and were justified.—*R. A. Dyke.*

DENVER FORECAST DISTRICT

Frost warnings were issued for the colder agricultural districts of Utah and western Colorado on the morning of June 7, on the morning of the 8th for Utah and southwestern Colorado, and again on the morning of the 9th for eastern Utah and southwestern Colorado. In each case these warnings were justified, as indicated by reports either of the actual occurrence of frost or of temperatures considerably below the critical point for frost formation. The coldest at Modena, Utah, was 2° above freezing, while at Durango, Colo., a temperature of 33° was recorded on the mornings of the 8th and 10th and of 32° on the morning of the 9th.

The cause of these low night temperatures was the development of a pronounced low-pressure area, the center of which passed eastward across the northern portion of the district, and the approach of an area of high pressure from the north Pacific States and adjacent Canadian Provinces, areas between which the pressure gradient was steep and temperature contrasts marked.

On the evening of Tuesday, the 17th, a fire-weather warning was issued to include the forested districts of Utah, Arizona, and New Mexico, forecasting strong westerly winds, local electric storms, and cooler weather, for Wednesday, the 18th, and probably Thursday, the 19th. The occasion for issuing the warning was that the fire hazard had become great, due to a deficiency of precipitation and to a week of unusually high temperatures, while a low-pressure area had developed marked intensity and showed that it was moving eastward. On the following day wind velocities reported by Weather Bureau offices and Forest Service lookout stations ranged from brisk winds to fresh gales. A velocity of 46 miles per

hour from the southwest was reported from Albuquerque, N. Mex., and from the Bill Williams Lookout Station, Ariz. By the 19th the wind subsided. It seems probable that local electric storms occurred within the more elevated forested districts, from which only a few reports are available at present.

Fire-weather warnings were issued again on the evening of Monday, the 23d, for fresh to strong winds, mostly westerly, for Tuesday, the 24th, to include Utah, northern Arizona, and northern New Mexico, and strong shifting, mostly westerly winds for Colorado, with thunderstorms probable in northeastern Colorado. This warning was occasioned by a low-pressure area over the plateau and Rocky Mountain regions, which was spreading and drifting eastward. Forests had continued very dry and inflammable and meteorological conditions indicated further and serious fire hazard. On the following day fresh to strong winds were reported at different points in the district, and local thunderstorms, generally without appreciable precipitation, occurred in eastern Colorado. Information was received through the press and cooperative observers of damage from wind, hail, and lightning in northeastern Colorado, one man having been killed by lightning and two others injured.—*Lawrence C. Fisher.*

SAN FRANCISCO FORECAST DISTRICT

The warm wave which prevailed over this district at the close of May continued until the 5th, and was broken on the 6th, when a depression moving through western Canada caused rain in the north Pacific states. Seasonable weather then prevailed, until another depression moving over western Canada gave rain in the northern portion of this district on the 17th, and 18th, with cooler weather.

A warm wave began to develop over this district on the 19th, and slowly increased in intensity until the end of the month. On the 30th, June records for high temperatures were broken at Walla Walla, Baker and Winnemucca.

Fire-weather warnings were issued throughout the district on the 19th, and 26th. Cautionary fire-weather warnings were distributed by radio broadcast from the 1st to the 5th, and from the 19th until the close of the month.

Special flying-weather forecasts along the coast were made for the Navy, from San Pedro to Port San Luis on the 27th, and from Port San Luis to San Francisco on the 28th.—*G. H. Willson.*

RIVERS AND FLOODS

By H. C. FRANKENFIELD, Meteorologist

There were no flood stages reached in the rivers of the Atlantic States during the month of June except for a single day, June 27, in the Santee River of South Carolina. Warnings were promptly issued after the heavy rains of June 24 and 25. No damage was done.

The Black Warrior River of Alabama was in flood near the end of May, and warnings were issued on May 29 for a flood in the Tombigbee River from Demopolis, Ala., to the mouth. Flood stages were reached on June 2 and continued for five days, with a crest at Lock No. 4, Demopolis, of 42.8 feet on June 4, 3.8 feet above flood stage. Only lowest bottoms were overflowed, about 3,300 acres, involving a loss in prospective crops of $23,500, and in suspension of business operations, $1,000. Value of property saved through warnings, $9,300.

During the month of May rains had been frequent and at times heavy over Ohio, Indiana, and Illinois with resulting floods. The same conditions continued during the first decade of June. Naturally the soil was well saturated and the first heavy rain brought about another rapid rise in all rivers, very few failing to exceed the flood stage. The floods, however, were moderate except in some of the smaller tributary steams in the State of Ohio, and as a rule only lowlands were flooded, and without damage of consequence. The only severe flood occurred in Mad River, a tributary of the Great Miami River of Ohio. In this river the flood did much damage, particularly along the Buck Creek section of the city of Springfield. Two hundred homes were flooded, steam and electric railroad service crippled, bridges washed away, crops destroyed, livestock drowned, and business retarded. The rain fell so rapidly that drainage ditches and sewers were overtaxed. The losses reported amounted to $535,000, of which $50,000 was in farm and truck products. The effectiveness of the Miami Conservancy project was again strikingly illustrated in the City of Dayton and below. The dams easily withstood the enormous pressure and triumphantly survived their greatest test since their completion.

There was, of course, some minor damage done below Dayton, mainly to lowlands without levee protection. Above Dayton, however, all tributary streams were out of their banks and great damage of the usual character was done. One of the largest items of expense was for the removing of immense masses of débris brought down by the flood waters.

The city of Piqua, on the main river, suffered severely through the collapse of the city waterworks raceway, flooding much of the western portion of the city, and compelling the suspension of railroad operations. The water supply from Piqua northward to Sidney was also cut off for a time.

Losses to crops in the Miami Valley were estimated at $1,000,000, much of it through inundation of crops planted in storage territory behind the conservancy dams, an occurrence that should be and is expected at times.

The floods in Indiana and Illinois were moderate as a rule, although prospective crop losses, 18,000 acres of wheat and corn, were estimated at $220,000, while suspension of business caused other losses of about $25,000. The money value of property saved through flood warnings was about $25,000.

For the first time since 1909 the Maumee River of Ohio reached the flood stage of 15 feet during the month of June. No warnings were necessary and no damage resulted.

Another destructive local flood occurred during the evening of June 13 in Carter County, Tenn., mainly along the upper Watauga River. Between 11 and 15 inches of rain fell within a few hours over a small portion of the narrow valley, drowning eleven persons and doing damage to the amount of $500,000. Six miles from the locus of the heaviest rain the fall was only 1 inch, and 15 miles away in another direction only from 0.50 to 1.60 inches.

The Tallahatchie River of Mississippi was in flood from June 6 to 27, inclusive, and about 30,000 acres of land, mostly uncultivated, were overflowed. Only nominal damage was done.

The Mississippi River at Keokuk, Iowa, passed the flood stage of 14 feet on June 29 for a single day, and at the close of the month was above the flood stage from Hannibal, Mo., to the mouth of the Missouri River at Alton, Ill. Moderate flood stages also prevailed for a

day or two at the end of the month in the Missouri River from Kansas City eastward. Warnings were issued at the proper time and apparently no damage was done. There were two more pronounced floods in the Grand River of Missouri, one from June 10 to 19, and the other from the 25th until after the close of the month. Report of this flood will be made later.

There were two floods in the Meramec River of Missouri for which warnings were issued at the proper time. The first one continued from May, and the second occurred on June 12 and 13.

A flood in the White River of Arkansas caused by heavy rains on June 10 and 11, prevailed from the 12th to the 23d, and in the upper river the crest stages were about 8 feet above the flood stages. Warnings were issued on June 11 and 12. The damage, only about one-half of which was reported, was about $102,000, of which $63,000 was in crops. The reported value of property saved through the warnings was $16,000.

There were also moderate floods in the Sabine, Neches, and lower Trinity and Guadalupe Rivers of Texas, and local floods in the Rio Grande and Colorado River of Colorado and Arizona, all of which were properly forecast. There was no damage of consequence except along the Sabine and Neches Rivers, where it amounted to about $42,500, of which $7,500 was in crops and $35,000 in business suspension. The money value of property saved through the warnings was $24,500.

River and station	Flood stage	Above flood stages—dates		Crest	
		From—	To—	Stage	Date
ATLANTIC DRAINAGE					
	Feet			*Feet*	
Santee: Rimini, S. C.	12	[1]	1	12.5	1
		27	27	12.4	27
EAST GULF DRAINAGE					
Tombigbee: Lock No. 4, Demopolis, Ala.	39	2	7	42.8	6
GREAT LAKES DRAINAGE					
Maumee: Fort Wayne Ind.	15	10	11	15.9	10
St. Joseph: Montpelier, Ohio	10	30	[2]	11.4	30
MISSISSIPPI DRAINAGE					
Kiskiminetas: Saltsburg, Pa.	8	29	29	12.0	29
Tuscarawas:					
Gnadenhutten, Ohio	10	12		11.9	12
		30	30	10.3	30
Coshocton, Ohio	8	11	13	9.8	12
Walhonding: Walhonding, Ohio	8			12.7	11
Scioto:					
LaRue, Ohio	11	9	11	12.8	9
Circleville, Ohio	10	9	11	14.7	10
Chillicothe, Ohio	16	10	11	20.8	10
Miami: Middletown, Ohio	15	10	10	15.6	10
Mad: Springfield, Ohio	11	8	13	13.3	8
Stillwater: Pleasant Hill, Ohio	13	8	9	15.7	9
Wabash:					
Lafayette, Ind.	11	8	14	18.6	11
		26	27	12.7	26
Terre Haute, Ind.	16	10	16	17.4	14
Vincennes, Ind.	14	16	19	14.9	17
Mount Carmel, Ill.	16	15	18	16.2	16
White (West Fork):					
Anderson, Ind.	12	9	10	14.0	10
Noblesville, Ind.	14	9	11	16.0	10
Elliston, Ind.	19	13	14	20.0	14
Edwardsport, Ind.	14	9	16	17.3	15
Mississippi:	*Feet*			*Feet*	
Keokuk, Iowa	14	29	29	14.2	29
Quincy, Ill.	14	29	30	15.2	30
Hannibal, Mo.	13	28	[3]	15.2	30
Louisiana, Mo.	12	28	[3]	13.8	30
Alton, Ill.	21	30	[3]		
Des Moines:	14	26	28	16.5	28
Tracy, Iowa	14	26	28	16.5	28
Ottumwa, Iowa	10	26	29	12.8	28
Raccoon: Van Meter, Iowa	13	25	25	15.2	25
Illinois:					
Morris, Ill.	13	26	30	14.5	29
Peru, Ill.	14	10	16	14.5	11–12
		24	[3]	18.4	30
Henry, Ill.	7	11	[3]	12.0	30
Peoria, Ill.	16	27	[3]	18.9	30
Havana, Ill.	14	28	[3]	16.4	30
Beardstown, Ill.	12	13	21	12.5	16–17
		25	[3]	16.7	30
Pearl, Ill.	12	28	[3]	13.4	30
Meramec:					
Pacific, Mo.	11	[1]	1	17.9	1
		12	12	11.2	12
Valley Park, Mo.	14	[1]	2	19.5	May 31
		13	13	14.6	13
Bourbeuse: Union, Mo.	10	[1]	[3]	14.1	May 31
		20	20	10.4	20
White:					
Calico Rock, Ark.	18	12	12	26.0	12
Batesville, Ark.	23	12	13	30.6	12
Georgetown, Ark.	22	18	20	22.0	18–20
Cache: Patterson, Ark.	9	4	8	9.7	6
Tallahatchie: Swan Lake, Miss.	25	6	26	26.0	14–16
Sulphur:					
Ringo Crossing, Tex.	20	[1]	3	25.1	May 30–31
Finley, Tex.	24	2	7	26.0	3–4
Missouri:					
Kansas City, Mo.	22	28	29	22.3	28
Waverly, Mo.	23	28	30	23.6	29
Hermann, Mo.	21	30	30	21.5	30
St. Charles, Mo.	25	19	21	25.6	20
		29	30	27.1	30
South Platte: North Platte, Nebr.	5	8	8	5.0	8
Grand:					
Gallatin, Mo.	20	13	14	27.7	14
		25	29	31.1	27
Chillicothe, Mo.	18	13	19	23.7	14
		26	[3]	28.1	29
Brunswick, Mo.	10	10	[3]	14.3	30
Trenton, Mo. (Thompson Fork)	20	26	30	24.9	24
WEST GULF DRAINAGE					
Sabine:					
Logansport, La.	25	1	7	27.9	3–4
Bon Wier, Tex.	20	6	12	20.6	7–8
Neches:					
Rockland, Tex.	22	2	4	22.1	2–3
Beaumont, Tex.	7	7	11	7.3	9
Trinity:					
Trinidad, Tex.	28	1	2	28.5	1
Liberty, Tex.	25	2	12	26.9	6–8
Guadalupe: Victoria, Tex.	16	2	6	22.4	4
		22	22	23.2	22
Rio Grande:					
San Marcial, N. Mex.	2	[1]	12	4.8	May 17–18
		19	20	2.0	19–20
San Benito, Tex.	21	4	5	22.7	5
COLORADO DRAINAGE					
Colorado:					
Fruita, Colo.	12	16	17	12.5	16
Lees Ferry, Ariz.	12	[1]	27	14.9	19
Parker, Ariz.	7	[1]	[2]	9.4	22
Carbondale, Colo. (Roaring Fork)	5	12	18	6.7	14
Eagle: Eagle, Colo.	5	14	17	5.4	16
Gunnison: Delta, Colo.	9	6	8	9.5	6–8
		14	16	9.6	14 & 16
PACIFIC DRAINAGE					
Columbia: Marcus, Wash.	24	[3]	9	26.7	May 27–28

[1] Continued from last month.
[2] Continued at end of month.
[3] Below flood stage at 8 a. m., June 1, 1924.

MEAN LAKE LEVELS DURING JUNE, 1924

By UNITED STATES LAKE SURVEY

[Detroit, Mich., July 8, 1924]

The following data are reported in the "Notice to Mariners" of the above date:

Data	Lakes [1]			
	Superior	Michigan and Huron	Erie	Ontario
Mean level during June, 1924:	*Feet*	*Feet*	*Feet*	*Feet*
Above mean sea level at New York	601.28	579.38	572.36	246.27
Above or below—				
Mean stage of May, 1924	+0.09	+0.14	+0.20	+0.17
Mean stage of June, 1923	−0.37	−0.47	+0.36	+0.34
Average for June last 10 years	−1.08	−1.44	−0.48	−0.40
Highest recorded June stage	−2.15	−4.22	−2.16	−2.36
Lowest recorded June stage	+0.04	−0.47	+0.79	+1.38
Average relation of the June level to—				
May level		+0.2	+0.2	+0.2
July level		−0.1	(2)	(2)

[1] Lake St. Clair's level: In June, 1924, 574.73 feet.
[2] Practically no difference.

EFFECT OF WEATHER ON CROPS AND FARMING OPERATIONS, JUNE, 1924

By J. B. KINCER

During the first 10 days of June cool weather continued unfavorable for spring crops in Central and Northern States, and farther south from the Rocky Mountains eastward there was further delay in cultivation. Weather conditions were more favorable, however, in the Southern States, where increased warmth favored normal growth of vegetation and the germination of late-sown seed, while the smaller amount of rainfall was favorable for cultivation.

Beginning about the middle of the month, however, there was a reaction to considerably warmer weather in the central valleys and Northern States, and for a period of about 10 days very good growing weather was experienced in these sections, while at the same time increased soil moisture in the upper Mississippi Valley and northern Plains area was very beneficial. West of the Rocky Mountains conditions remained very unfavorable for small grains and grass on account of warmth and dryness, though irrigated crops did well.

Night temperatures in Northern States east of the Rocky Mountains were again rather too low for best growth of warm-weather crops during the latter part of the month, while further rain in many interior sections, especially in the lower Missouri and upper Mississippi Valleys delayed the cultivation of crops. Good growing weather prevailed in the Atlantic coast area, however, and crops showed general improvement in central-eastern and southeastern districts. In the west Gulf area, however, only local rains occurred, more moisture was needed, and the progress of most crops irregular, depending on local rainfall.

The month, on the whole, was favorable for ripening winter wheat in the principal producing areas. Harvesting took place in the western portion of the Winter Wheat Belt at about the average time for cutting, but wheat was ripening late in the more eastern districts. At the close of the month harvesting was in progress northward to southern Maryland, extreme northern Kentucky, southern Illinois, and southern Nebraska. The cool weather and ample moisture in Central-Northern States favorably affected spring wheat, and satisfactory progress was quite generally reported. In North Dakota early wheat was heading at the close of the month. Oats made fair to good progress and showed improvement in most interior and northern sections of the country, though there was complaint of weeds in portions of the Ohio Valley.

The weather was unfavorable for corn in most sections. The plants grew slowly under the influence of cool weather and there was too much rain in many sections, especially from the upper Mississippi Valley eastward. There was much complaint of weedy fields at the close of the month, and in most States the crop was in very poor condition.

Considerably better cotton weather prevailed than during the preceding month. There was less rainfall and temperatures were considerably higher, which was more favorable for cultivation, especially in the eastern portion of the belt. In Texas the well-rooted cotton made good growth, but that planted later suffered injury from hot, dry, weather. In Oklahoma the crop showed improvement and in Arkansas good to excellent advance was reported during much of the month, while in Louisiana dry warm weather was helpful for cultivation and favored good growth. Much cultivation was accomplished in central and eastern portions of the belt and fair to good growth was reported in most sections, especially in Georgia where fields were well tilled at the close of the month.

Potatoes and hardy truck crops did well in Central-Northern States, under the influence of cool, moist weather, but gardens, and warm-weather crops were less favorably affected. In the South minor crops made good advance in the east Gulf area, but in the west Gulf section where soil was becoming very dry at the close of the month more rain was needed.

It was too dry for ranges and pastures in the more western States, where stock water was scarce and the range drying and browning. Livestock were falling off in condition in many sections.

CLIMATOLOGICAL TABLES

CONDENSED CLIMATOLOGICAL SUMMARY

In the following table are given for the various sections of the climatological service of the Weather Bureau the monthly average temperature and total rainfall; the stations reporting the highest and lowest temperatures, with dates of occurrence; the stations reporting the greatest and least total precipitation; and other data as indicated by the several headings.

The mean temperature for each section, the highest and lowest temperatures, the average precipitation, and the greatest and least monthly amounts are found by using all trustworthy records available.

The mean departures from normal temperatures and precipitation are based only on records from stations that have 10 or more years of observations. Of course, the number of such records is smaller than the total number of stations.

Condensed climatological summary of temperature and precipitation by sections, June, 1924

Section	Temperature								Precipitation					
			Monthly extremes								Greatest monthly		Least monthly	
	Section average	Departure from the normal	Station	Highest	Date	Station	Lowest	Date	Section average	Departure from the normal	Station	Amount	Station	Amount
	° F.	° F.		° F.			° F.		In.	In.		In.		In.
Alabama	79.5	+1.3	Thomasville	102	16	Scottsville	49	3	5.35	+0.94	Spring Hill	14.08	Cochrane	0.73
Alaska														
Arizona	78.7	+2.9	Quartzsite	119	14	Long Valley	24	14	0.14	−0.20	Baboquivari	1.51	33 stations	0.00
Arkansas	78.5	+1.7	Texarkana	105	12	Dutton	42	2	3.64	−0.44	Calico Rock	9.90	Portland	0.27
California	68.8	+0.5	Greenland Ranch	123	†29	Portola	24	16	0.02	−0.31	Crescent City	0.85	190 stations	0.00
Colorado	62.5	+1.1	Lamar	105	18	2 stations	14	†8	0.39	−1.09	Holly	2.80	7 stations	0.00
Florida	81.6	+1.9	2 stations	102	21	DeFuniak Springs	61	5	6.16	−0.29	Lake Wales	14.59	Fort Pierce	0.69
Georgia	79.8	+1.6	do	105	†21	Clayton	45	1	4.59	−0.04	Young Cane	9.09	Dahlonega	1.66
Hawaii	73.1	+0.3	Mahukona	92	†20	Volcano Observatory.	51	29	2.40	−3.27	2 stations	11.00[4]	10 stations	0.00
Idaho	60.6	+0.5	Weiser	110	30	Stanley	16	16	0.61	−0.70	2 stations	2.10	2 stations	T
Illinois	70.0	−1.5	2 stations	98	19	Joliet	35	4	6.82	+2.97	Monmouth	12.02	Paris	1.94
Indiana	70.1	−1.3	Whiting	99	19	2 stations	38	†2	6.23	+2.39	Collegeville	10.19	Shoals	2.80
Iowa	66.8	−2.5	Columbus Junction	96	19	Inwood	35	6	8.10	+3.58	Cumberland	14.92	Sanborn	4.00
Kansas	74.1	+0.9	5 stations	108	†12	2 stations	36	1	2.17	−1.66	Independence	7.94	Trousdale	0.00
Kentucky	74.2	+0.3	2 stations	99	†19	Anchorage	42	1	4.39	+0.30	Ravenna	8.37	Burnside	1.92
Louisiana	82.1	+2.1	3 stations	102	†11	3 stations	55	4	3.01	−1.86	Abbeville	7.78	Minden	0.40
Maryland-Delaware	69.3	−1.3	Frederick, Md	99	20	Oakland, Md	33	5	5.27	+1.19	Wilmington, Del	8.35	Frederick, Md	2.74
Michigan	61.5	−1.9	3 stations	96	†20	Humboldt	25	3	3.22	+0.12	Cassopolis	7.80	Mackinac Island	1.01
Minnesota	61.1	−3.3	Mapleplain	93	14	2 stations	26	†2	4.27	+0.31	Minneapolis No. 1	8.79	Gonvick	1.45
Mississippi	81.3	+2.6	2 stations	103	†16	do	56	†2	3.48	−0.73	Fulton	9.49	Stoneville	0.30
Missouri	72.5	−1.0	Caruthersville	101	†24	Hollister	38	†2	7.39	+2.72	Maryville	13.53	Poplar Bluff	2.62
Montana	57.1	−2.6	Thompson Falls	101	30	Brenner	17	7	2.73	−0.03	Babb	7.98	Brenner	0.21
Nebraska	67.1	−2.1	Imperial	102	18	Harrison	32	20	4.27	+0.48	Norfolk	12.28	McCook	0.18
Nevada	66.7	+2.0	Logandale	113	29	Rye Patch	19	19	0.09	−0.46	Tuscarora	0.62	27 stations	0.00
New England	61.9	−2.2	New Bedford, Mass	93	24	Garfield, Vt	26	1	2.02	−1.21	Nantucket, Mass	4.51	Presque Isle, Me	0.76
New Jersey	66.8	−1.8	2 stations	95	25	Charlotteburg	30	1	4.20	+0.48	Imlaystown	7.32	Charlotteburg	1.72
New Mexico	72.1	+3.1	do	111	†18	Lee's Ranch	18	†10	0.41	−0.96	Tucumcari No. 2	3.45	28 stations	0.00
New York	62.8	−2.0	Dansville	94	20	3 stations	27	†1	2.75	−0.84	Binghamton	5.38	Moira	1.10
North Carolina	74.6	+1.6	Kinston	105	21	Mount Mitchell	35	3	5.31	+0.04	Red Springs	12.53	Cullowhee	0.98
North Dakota	58.6	−4.2	Bottineau	89	30	Grafton	26	7	4.17	+0.67	Bowbells	7.57	Pembina	1.85
Ohio	68.0	−1.3	Green	99	20	Paulding	35	7	6.38	+2.60	West Manchester	12.21	Marietta Exp. Farm	3.01
Oklahoma	80.5	+4.0	4 stations	113	18	2 stations	40	1	3.35	−0.57	Webbers Falls	10.72	Kenton	0.29
Oregon	61.9	+1.8	Echo	112	30	Fremont	17	8	0.74	−0.54	Headworks	3.13	Falls City	0.00
Pennsylvania	65.8	−1.7	Gettysburg	98	20	West Bingham	26	1	5.57	+1.47	Biglerville	9.75	Scranton	2.23
Porto Rico	78.1	−0.3	2 stations	98	†6	Utuado	55	18	5.35	−1.25	Lares	18.70	Potala	0.21
South Carolina	78.7	+1.1	7 stations	104	†20	2 stations	52	†4	5.12	+0.28	Georgetown	13.02	Calhoun Falls	1.04
South Dakota	62.6	−3.3	3 stations	100	14	La Delle	28	6	4.88	+1.34	La Delle	10.43	Elm Springs (near)	0.56
Tennessee	75.9	+1.4	Loudon	101	20	Johnson City	41	1	3.42	−1.04	Johnsonville	6.72	Nashville	0.91
Texas	82.1	+1.9	2 stations	114	†15	Lieb (near)	41	1	2.12	−1.07	Ricardo	12.42	7 stations	0.00
Utah	66.5	+2.2	St. George	110	29	Panguitch	17	†8	0.12	−0.52	High Line City Creek	0.71	50 stations	0.00
Virginia	71.2	−0.7	Franklin	102	20	Burkes Garden	35	5	4.98	+0.49	Cape Henry	8.98	Quantico	1.31
Washington	61.0	+1.1	Wahluke	110	30	Paradise Inn	16	6	0.91	−0.57	2 stations	3.03	Yakima	0.04
West Virginia	68.7	−0.1	2 stations	98	20	Cheat Bridge	32	5	4.67	+0.08	Sutton	7.63	Upper Tract	1.90
Wisconsin	61.1	−3.6	Oconto	92	21	Long Lake	24	7	4.23	+0.29	Williams Bay	8.72	Plum Island	1.57
Wyoming	57.8	−0.7	Yoder	99	26	Gallatin	13	7	0.65	−0.91	Colony	2.93	6 stations	0.00

For description of tables and charts, see REVIEW, January, 1924, pp. 56–57.

† Other dates also.

TABLE 1.—*Climatological data for Weather Bureau stations, June, 1924*

Districts and stations	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. +2 mean min. +2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01, or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	*Ft.*	*Ft.*	*In.*	*In.*	*In.*	°F.	°F.	°F.		°F.	°F.		°F.	°F.	°F.	°F.	%	*In.*	*In.*		*Miles*							*0–10*	*In.*	*In.*
New England							**62.1**	**−1.4**										**76**	**2.11**	**−1.0**									**5.4**		
Eastport	76	67	85	29.82	29.90	−.03	55.0	−0.1	76	26	64	42	6	46	27	50	46	78	1.92	−1.3	10	5,811	s.	31	ne.	15	5	11	14	6.3	0.0	0.0
Greenville, Me.	1,070	6	----	28.76	29.90	------	57.8	------	82	23	70	34	3	46	38	----	----	----	1.75	------	14	----	nw.	----	----	----	15	5	10	----	0.0	0.0
Portland, Me.	103	82	117	29.82	29.94	−.01	61.6	−0.9	87	24	70	44	1	53	31	55	49	67	1.74	−1.6	9	5,985	s.	26	nw.	1	10	10	10	5.3	0.0	0.0
Concord	288	70	79	29.62	29.92	−.04	62.4	−0.5	87	24	76	37	1	49	40	----	----	----	1.59	−1.8	6	3,454	n.	23	sw.	6	13	11	6	4.3	0.0	0.0
Burlington	404	11	48	29.48	29.91	−.05	61.8	−2.0	83	24	73	33	1	51	34	----	----	----	2.90	−0.4	10	6,426	s.	42	s.	6	7	13	10	5.9	0.0	0.0
Northfield	876	12	60	28.99	29.93	−.03	58.6	−4.1	83	24	73	30	1	44	42	56	53	79	2.51	−0.7	7	4,595	s.	29	sw.	29	3	14	13	6.6	0.0	0.0
Boston	125	115	188	29.80	29.93	−.03	66.6	+0.1	90	24	75	48	11	58	25	58	53	66	1.07	−2.0	6	6,343	sw.	30	se.	21	10	14	6	5.3	0.0	0.0
Nantucket	12	14	90	29.93	29.94	−.04	59.8	−1.5	81	22	66	44	11	53	22	56	55	88	4.51	+2.1	10	9,366	sw.	42	n.	15	10	7	13	6.0	0.0	0.0
Block Island	26	11	46	29.91	29.94	−.03	60.5	−1.3	78	22	66	47	11	55	17	57	55	88	2.56	−0.3	12	9,007	sw.	37	n.	25	13	8	9	5.0	0.0	0.0
Providence	160	215	251	29.77	29.94	−.03	65.0	−3.3	88	22	74	44	11	56	24	58	53	68	1.05	−2.1	7	5,795	s.	43	nw.	25	10	12	8	5.1	0.0	0.0
Hartford	159	122	140	29.77	29.94	−.03	66.2	−0.9	86	22	76	47	1	56	27	----	----	----	1.62	−1.5	10	----	s.	----	----	----	13	7	10	4.8	0.0	0.0
New Haven	106	74	153	29.83	29.94	−.03	65.6	−1.0	90	25	74	48	1	57	28	59	54	71	1.75	−1.4	11	5,358	s.	35	n.	25	9	12	9	5.0	0.0	0.0
Middle Atlantic States							**68.8**	**−1.4**										**77**	**4.51**	**+0.8**									**6.2**		
Albany	97	102	115	29.82	29.92	−.05	65.8	−2.2	89	29	76	42	1	56	33	60	55	71	1.86	−1.9	11	5,086	s.	33	s.	29	14	6	10	5.1	0.0	0.0
Binghamton	871	10	84	29.00	29.92	−.05	64.1	−2.1	86	19	74	38	1	54	38	----	----	----	5.38	+1.8	12	3,417	ne.	29	sw.	29	5	13	12	6.4	0.0	0.0
New York	314	414	454	29.62	29.95	−.03	66.8	−2.0	87	25	74	51	9	59	25	60	55	72	2.74	−0.5	10	8,668	s.	74	sw.	25	1	16	13	7.1	0.0	0.0
Harrisburg	374	94	104	29.57	29.96	−.03	68.4	−1.9	94	20	77	51	2	60	27	61	57	72	6.47	+2.9	18	3,805	w.	33	w.	25	3	11	16	6.9	0.0	0.0
Philadelphia	114	123	190	29.83	29.96	−.02	69.3	−2.1	92	21	78	51	9	61	28	62	58	71	4.31	+1.0	13	5,514	w.	31	ne.	25	2	9	19	7.7	0.0	0.0
Reading	325	81	98	29.61	29.95	------	68.0	------	90	25	77	50	1	59	28	63	60	79	5.15	+1.5	14	3,943	se.	34	nw.	25	6	15	9	6.0	0.0	0.0
Scranton	805	111	119	29.11	29.96	−.02	65.4	−1.8	86	29	75	39	1	56	30	62	59	80	2.23	−1.3	14	4,069	s.	33	sw.	29	7	10	13	6.0	0.0	0.0
Atlantic City	52	37	172	29.89	29.95	−.03	66.3	−0.3	89	21	72	53	1	61	23	62	60	83	3.56	+0.5	11	9,972	s.	53	w.	25	7	14	9	5.4	0.0	0.0
Cape May	17	13	49	29.97	29.99	+.01	67.8	+0.1	89	21	75	52	10	60	23	63	61	86	3.86	+0.8	15	4,926	s.	35	nw.	25	9	6	15	6.4	0.0	0.0
Sandy Hook	22	10	55	29.92	29.94	------	66.2	------	89	25	73	52	8	59	24	60	58	79	3.61	------	15	7,137	s.	56	w.	25	2	17	11	6.4	0.0	0.0
Trenton	190	159	183	29.75	29.95	------	67.8	------	90	25	77	50	1	59	28	62	59	78	5.31	+1.8	14	6,217	sw.	62	nw.	25	3	13	14	7.0	0.0	0.0
Baltimore	123	100	113	29.82	29.95	−.04	71.2	−1.5	96	20	79	53	2	63	24	64	60	73	5.54	+1.7	13	3,816	s.	26	ne.	20	7	8	15	6.7	0.0	0.0
Washington	112	62	85	29.83	29.95	−.05	71.3	−0.9	95	20	81	50	1	62	27	65	62	76	3.89	−0.3	14	3,649	s.	36	nw.	8	5	16	9	6.0	0.0	0.0
Cape Henry	18	8	54	29.92	29.94	------	72.2	------	94	29	79	58	3	66	25	68	66	84	8.98	+4.6	16	7,888	se.	68	nw.	21	3	17	10	6.3	0.0	0.0
Lynchburg	681	153	188	29.21	29.94	−.07	72.1	−2.5	97	20	82	48	5	62	32	66	64	78	3.58	−0.3	16	4,100	w.	58	n.	8	6	14	10	5.9	0.0	0.0
Norfolk	91	170	205	29.87	29.97	−.03	73.9	−0.5	98	20	82	58	3	66	28	67	65	81	6.46	+2.1	15	7,919	s.	60	w.	29	2	15	13	6.8	0.0	0.0
Richmond	144	11	52	29.81	29.95	−.06	72.8	−1.3	96	20	82	55	5	64	29	67	65	80	4.85	+1.3	20	4,462	se.	46	nw.	18	11	6	13	5.5	0.0	0.0
Wytheville	2,304	49	55	27.65	29.96	−.05	68.7	0.0	88	20	79	45	5	58	30	63	61	80	2.01	−2.1	16	3,550	w.	30	w.	29	12	13	5	4.6	0.0	0.0
South Atlantic States							**77.9**	**+1.4**										**79**	**5.34**	**+0.4**									**5.6**		
Asheville	2,255	70	84	27.69	29.97	−.04	71.4	+2.7	91	29	81	50	5	62	29	64	62	79	1.91	−2.3	15	4,410	n.	28	nw.	9	9	18	3	4.6	0.0	0.0
Charlotte	779	55	62	29.14	29.96	−.05	77.0	+1.5	100	20	88	57	4	66	28	69	66	75	7.86	+3.4	12	2,372	sw.	30	nw.	14	6	17	7	6.0	0.0	0.0
Hatteras	11	11	50	29.95	29.96	−.05	74.4	−1.2	90	21	80	60	15	69	18	71	70	86	7.15	+2.8	12	8,753	sw.	42	nw.	22	9	12	9	5.4	0.0	0.0
Manteo	12	5	42	----	----	----	73.9	----	97	20	----	51	15	----	30	----	----	----	7.84	------	7	----	s.	----	----	----	17	8	5	----	0.0	0.0
Raleigh	376	103	110	29.56	29.95	−.06	75.9	+0.2	100	21	86	57	4	66	31	69	66	79	6.75	+2.0	13	5,001	sw.	33	ne.	13	5	15	10	6.0	0.0	0.0
Wilmington	78	81	91	29.90	29.97	−.04	77.4	+0.6	99	20	86	62	4	69	25	72	71	84	8.23	+2.6	20	4,796	sw.	30	n.	13	7	15	8	5.6	0.0	0.0
Charleston	48	11	92	29.93	29.98	−.03	81.2	+2.3	101	21	88	66	4	74	20	75	73	80	2.39	−3.0	10	7,239	sw.	36	w.	30	6	15	9	5.9	0.0	0.0
Columbia, S. C.	351	41	57	29.60	29.97	−.04	79.7	+1.6	102	20	90	61	4	70	27	72	70	82	5.45	+1.3	10	4,182	s.	35	s.	26	6	17	7	5.4	0.0	0.0
Due West	711	10	55	29.20	29.99	------	77.6	------	99	20	89	57	4	67	27	----	----	----	2.87	------	11	5,122	sw.	38	nw.	9	5	17	8	5.9	0.0	0.0
Greenville, S. C.	1,039	113	122	28.88	29.95	------	76.6	+2.5	99	20	86	57	4	67	28	69	65	74	2.26	------	10	4,940	sw.	50	nw.	24	7	20	3	5.0	0.0	0.0
Augusta	180	62	77	29.77	29.96	−.05	80.7	+2.0	102	21	91	60	4	70	27	73	70	75	5.56	+1.0	13	3,515	s.	33	se.	24	6	18	6	5.4	0.0	0.0
Savannah	65	150	194	29.91	29.98	−.03	81.3	+2.3	101	21	91	65	4	72	24	73	71	80	3.86	−2.2	14	7,293	sw.	44	w.	24	11	14	5	5.2	0.0	0.0
Jacksonville	43	209	245	29.95	30.00	−.01	81.2	+1.3	98	21	90	67	7	73	26	73	71	78	4.21	−1.3	17	6,938	sw.	69	sw.	24	2	20	8	6.2	0.0	0.0
Florida Peninsula							**82.1**	**+1.3**										**75**	**5.25**	**−1.3**									**5.0**		
Key West	22	10	64	29.97	29.99	.00	83.2	+1.3	90	9	88	72	14	78	18	76	73	72	3.18	−1.1	10	5,449	se.	30	se.	6	13	13	4	4.4	0.0	0.0
Miami	25	71	79	29.99	30.02	------	81.1	+0.7	90	14	87	68	10	75	20	75	72	76	4.22	−2.9	12	4,156	se.	32	nw.	16	8	13	9	5.3	0.0	0.0
Sand Key	23	39	72	29.98	30.01	+.02	81.8	------	87	9	84	71	6	80	12	76	74	74	1.14	------	5	6,822	se.	50	e.	6	15	13	2	3.9	0.0	0.0
Tampa	35	79	87	29.97	30.00	−.01	82.0	+2.0	94	29	90	68	10	74	26	74	72	77	8.36	0.0	16	3,489	e.	40	w.	17	0	23	7	6.3	0.0	0.0
East Gulf States							**80.1**	**+1.6**										**77**	**5.27**	**+0.7**									**5.4**		
Atlanta	1,174	190	216	28.78	29.99	−.02	77.6	+1.6	93	19	86	59	3	69	21	69	66	71	3.14	−0.7	10	5,985	nw.	48	nw.	1	11	7	12	5.5	0.0	0.0
Macon	370	78	87	29.58	29.97	−.04	79.9	+1.0	98	20	90	61	3	70	25	71	68	72	4.48	+0.9	15	3,565	sw.	37	nw.	24	5	19	6	5.7	0.0	0.0
Thomasville	273	49	58	29.70	29.99	−.01	80.6	+1.1	98	21	91	66	7	71	27	73	71	80	7.19	+2.5	17	2,792	sw.	20	sw.	21	0	15	15	7.3	0.0	0.0
Apalachicola	36	42	49	29.95	29.99	------	81.2	------	92	22	87	69	3	75	18	76	74	81	4.44	------	12	3,998	sw.	24	sw.	9	14	12	4	4.5	0.0	0.0
Pensacola	56	149	185	29.93	29.99	.00	79.3	0.0	91	21	85	67	3	73	20	75	73	81	7.11	+2.2	14	7,126	sw.	48	e.	14	1	18	11	6.8	0.0	0.0
Anniston	741	9	57	29.23	30.01	+.01	77.6	+2.6	95	25	89	57	4	67	28	----	----	----	3.92	0.0	14	2,521	w.	30	n.	9	13	14	3	4.3	0.0	0.0
Birmingham	700	11	48	29.25	30.00	+.01	78.9	+1.0	96	25	89	60	4	69	28	71	68	76	6.85	+3.0	13	3,368	s.	26	s.	28	6	18	6	5.1	0.0	0.0
Mobile	57	125	161	29.93	29.99	.00	81.5	+1.9	98	14	90	67	16	74	24	75	73	82	9.39	+3.4	15	5,553	sw.	56	ne.	16	3	24	3	5.2	0.0	0.0
Montgomery	223	100	112	29.74	29.98	−.02	80.8	+1.2	95	15	90	63	3	71	24	73	70	77	4.68	+0.5	14	3,718	sw.	35	w.	25	2	21	7	6.4	0.0	0.0
Corinth	469	6	----	----	----	----	79.6	----	96	18	90	57	2	70	27	----	----	----	3.84	------	10	----	s.	----	----	----	4	24	2	----	0.0	0.0
Meridian	375	85	93	29.58	29.96	−.02	80.7	+2.6	96	16	90	62	4	71	26	73	71	77	4.77	+0.2	12	3,456	sw.	30	nw.	16	7	19	4	5.0	0.0	0.0
Vicksburg	247	65	73	29.71	29.99	+.02	81.0	+2.0	96	16	90	65	4	73	26	74	71	76	2.17	−2.3	4	4,066	sw.	36	se.	19	18	7	5	3.7	0.0	0.0
New Orleans	53	76	84	29.93	29.98	.00	83.3	+2.7	96	13	91	71	2	76	19	75	73	74	4.27	−1.9	12	3,663	s.	26	ne.	16	10	15	5	4.8	0.0	0.0
West Gulf States							**80.9**	**+1.8**										**74**	**3.22**	**−0.4**									**3.6**		
Shreveport	249	77	93	29.68	29.94	−.02	82.5	+2.9	98	14	92	63	3	73	22	73	69	70	1.04	−2.5	4	4,954	s.	25	s.	11	18	8	4	3.0	0.0	0.0
Bentonville	1,303	11	44	----	----	----	75.5	+1.4	93	13	85	50	2	66	27	----	----	----	4.74	------	11	3,979	s.	24	s.	9	12	9	9	----	0.0	0.0
Fort Smith	457	79	94	29.42	29.88	−.06	80.0	+2.5	99	28	90	55	2	70	29	72	68	70	3.96	0.0	8	6,052	s.	51	w.	9	10	15	5	4.6	0.0	0.0
Little Rock	357	136	144	29.56	29.92	−.04	79.3	+1.9	95	15	88	60	3	70	25	72	68	73	2.89	−1.2	13	6,528	s.	34	nw.	10	13	10	7	4.4	0.0	0.0
Brownsville	57	53	61	29.83	29.89	------	82.6	------	93	14	90	69	3	76	19	76	74	81	7.00	------	7	5,589	s.	22	s.	8	22	6	2	2.6	0.0	0.0
Corpus Christi	20	11	73	29.92	29.94	+.04	81.8	+1.2	91	16	87	72	4	76	17	76	75	82	9.40	+6.7	4	9,225	s.	40	se.	21	19	6	5	2.7	0.0	0.0
Dallas	512	109	117	29.37	29.90	------	83.3	------	102	15	93	61	3	74	26	----	----	----	1.65	------	5	7,794	s.	29	se.	7	16	13	1	3.4	0.0	0.0
Fort Worth	670	106	114	29.17	29.87	−.05	83.4	+3.3	105	15	94	60	3	73	28	71	66	62	1.25	−1.7	4	9,132	s.	39	nw.	2	16	12	3	3.4	0.0	0.0
Galveston	54	106	114	29.91	29.98	+.03	81.5	+0.8	89	30	86	68	2	78	15	76	74	82	2.51	−2.2	3	7,733	s.	38	se.	20	21	5	4	2.8	0.0	0.0
Groesbeck	461	11	56	29.44	29.91	------	80.7	----	95	13	90	62	3	72	23	----	----	----	1.09	------	5	8,283	s.	34	nw.	2	13	14	3	3.9	0.0	0.0
Houston	138	111	121	29.81	29.94	------	82.4	+1.4	96	13	91	69	4	74	22	----	----	----	3.67	------	5	4,854	s.	27	e.	20	12	13	5	4.3	0.0	0.0
Palestine	510	64	72	29.42	29.94	.00	80.3	+1.3	94	13	89	61	3	72	22	72	69	73	2.68	−1.3	4	5,680	s.	24	s.	10	16	10	4	4.0	0.0	0.0
Port Arthur	34	58	66	29.92	29.96	------	82.1	------	93	15	88	67	2	76	18	76	73	79	4.50	------	5	6,367	s.	31	w.	2	20	4	6	3.5	0.0	0.0
San Antonio	693	119	132	29.20	29.92	+.02	81.2	+0.8	97	15	91	63	1	72	25	72	68	71	4.66	+1.6	5	5,787	s.	45	nw.	1	17	11	2	3.5	0.0	0.0
Taylor	583	55	63	29.35	29.96	+.04	81.9	+1.9	98	15	92	63	3	72	26	----	----	----	0.55	−3.0	3	7,528	s.	26	s.	18	15	11	4	3.7	0.0	0.0

TABLE 1.—*Climatological data for Weather Bureau stations, June, 1924*—Continued

Districts and stations	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01, or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
Ohio Valley and Tennessee	*Ft.*	*Ft.*	*Ft.*	*In.*	*In.*	*In.*	*°F.*	*°F.*	*°F.*		*°F.*	*°F.*		*°F.*	*°F.*	*°F.*	*°F.*	*%*	*In.*	*In.*		*Miles*								*0–10*	*In.*	*In.*
							72.7	**−0.1**										**74**	**4.50**	**+0.3**										**6.1**		
Chattanooga	762	189	213	29.17	29.96	−.04	76.8	+1.4	94	20	86	56	1	68	27	69	66	73	3.84	−0.5	14	4,545	sw.	36	nw.	25	6	19	5	5.4	0.0	0.0
Knoxville	996	102	111	28.93	29.96	−.04	76.2	+2.2	96	20	86	55	5	66	31	69	66	74	3.75	−0.4	11	4,186	sw.	29	w.	25	0	11	19	7.7	0.0	0.0
Memphis	399	76	97	29.52	29.94	−.03	78.6	+1.0	94	17	86	58	2	71	24	71	68	71	3.62	−0.8	11	4,278	sw.	35	nw.	14	9	13	9	5.0	0.0	0.0
Nashville	546	168	191	29.40	29.97	−.02	77.0	+1.4	94	20	86	55	1	68	24	70	66	72	0.91	−3.5	8	5,414	sw.	34	nw.	13	6	18	6	5.6	0.0	0.0
Lexington	989	193	230	28.90	29.94	−.06	73.0	+0.8	92	20	82	53	2	64	27				4.04	0.0	15	7,704	sw.	48	sw.	29	7	15	8	5.6	0.0	0.0
Louisville	525	219	255	29.37	29.95	−.03	74.4	−0.3	93	19	83	53	2	66	25	67	64	72	6.20	+2.0	17	6,740	sw.	42	nw.	26	2	18	10	6.0	0.0	0.0
Evansville	431	139	175	29.48	29.94	−.03	75.4	+0.3	94	20	84	53	2	66	28	68	64	72	4.03	−0.1	13	6,947	sw.	58	sw.	20	2	23	5	6.0	0.0	0.0
Indianapolis	822	194	230	29.06	29.93	−.04	70.4	−1.2	93	19	79	45	2	62	25	64	60	75	4.04	−0.3	12	6,877	s.	50	w	20	4	19	7	5.9	0.0	0.0
Royal Center	736	11	55	29.13	29.92	.....	66.2	.....	92	19	76	41	2	56	29				6.57	.....	16	5,798	n.	48	w.	22	6	11	13	6.5	0.0	0.0
Terre Haute	575	96	129	29.31	29.92	.....	71.4	.....	94	19	80	48	2	63	27	66	64	79	3.52	.....	15	5,940	s.	44	nw.	5	0	22	8	6.6	0.0	0.0
Cincinnati	628	11	51	29.26	29.93	−.06	71.4	+0.2	94	20	81	47	4	62	27		64	76	6.75	+2.8	14	3,986	sw.	34	sw.	28	5	17	8	6.2	0.0	0.0
Columbus	824	179	222	29.08	29.94	−.05	69.0	−1.9	93	20	78	51	4	60	25	64	61	78	5.37	+1.9	16	5,562	sw.	36	nw	29	4	14	12	6.4	0.0	0.0
Dayton	899	137	173	28.98	29.92	.....	70.0	−2.2	93	20	79	51	7	61	26	64	60	73	7.59	+3.6	17	5,439	ne.	38	nw.	5	6	18	6	5.6	0.0	0.0
Elkins	1,947	59	67	27.96	29.95	−.05	66.5	−0.4	88	19	77	39	5	56	35	61	59	81	5.18	+0.1	16	3,025	nw.	35	nw.	8	1	14	15	7.1	0.0	0.0
Parkersburg	638	77	84	29.31	29.96	−.04	71.0	−0.4	95	20	81	49	5	61	28	64	60	72	3.25	−1.4	10	3,210	s.	36	nw.	9	9	10	11	5.6	0.0	0.0
Pittsburgh	842	353	410	29.05	29.94	−.05	68.6	−2.1	91	20	77	50	5	60	26	61	56	67	4.39	+0.5	13	6,305	sw.	39	w.	25	4	15	11	6.4	0.0	0.0
Lower Lake Region							**64.2**	**−2.6**										**73**	**3.85**	**+0.3**										**5.5**		
Buffalo	767	247	280	29.12	29.94	−.03	62.4	−2.0	82	19	70	44	9	55	25	57	53	75	2.69	−0.4	11	9,535	sw.	80	w.	21	9	13	8	5.6	0.0	0.0
Canton	448	10	61	29.42	29.89	.....	62.0	−3.8	80	21	73	39	9	51	34				2.08	−1.4	11	6,684	sw.	42	sw.	29	21	7	2	2.8	0.0	0.0
Oswego	335	76	91	29.56	29.92	−.05	60.7	−4.1	84	20	69	44	8	52	28	55	51	71	4.13	+0.7	12	5,314	w.	40	sw.	21	7	11	12	5.7	0.0	0.0
Rochester	523	86	102	29.38	29.94	−.03	64.4	−1.7	86	20	74	43	1	55	30	57	52	66	2.81	−0.3	11	4,599	sw.	50	w.	21	11	14	5	5.2	0.0	0.0
Syracuse	597	97	113	29.31	29.95	−.02	63.6	−3.3	84	20	72	43	9	55	31				1.97	−1.9	12	5,225	s.	52	sw.	21	5	14	11	6.2	0.0	0.0
Erie	714	130	166	29.17	29.93	−.05	64.7	−1.5	88	20	72	48	1	57	23	59	55	72	2.93	−0.8	9	8,313	w.	52	nw.	20	6	18	6	5.2	0.0	0.0
Cleveland	762	190	201	29.12	29.94	−.04	64.8	−2.3	90	20	72	49	8	58	27	59	56	73	5.73	+2.0	18	6,821	s.	60	nw.	20	2	18	10	6.6	0.0	0.0
Sandusky	629	62	70	29.25	29.93	−.05	66.0	−2.8	92	20	74	46	2	58	29				7.68	+3.9	17	4,449	sw.	56	nw.	28	3	16	11	6.5	0.0	0.0
Toledo	628	208	243	29.26	29.93	−.04	66.4	−2.3	92	20	75	43	4	58	26	61	58	76	5.35	+2.0	19	7,883	sw.	55	w.	28	10	13	7	5.3	0.0	0.0
Fort Wayne	856	113	124	29.03	29.95	.....	66.0	−2.5	90	20	75	44	2	57	28	62	59	81	5.80	.....	16	5,110	sw.	39	nw.	22	1	14	15	6.9	0.0	0.0
Detroit	730	218	258	29.16	29.94	−.03	65.6	−1.8	93	20	74	47	9	57	26	58	53	67	3.15	−0.7	12	6,182	sw.	33	nw.	20	14	10	6	4.4	0.0	0.0
Upper Lake Region							**60.5**	**−2.6**										**72**	**3.06**	**−0.3**										**5.8**		
Alpena	609	13	92	29.27	29.93	−.03	58.4	−2.0	85	22	68	36	8	49	28	53	49	72	2.95	−0.6	9	6,896	se.	35	se.	5	8	13	9	5.6	0	0.0
Escanaba	612	54	60	29.26	29.92	−.02	57.9	−2.8	82	21	66	38	7	49	27	52	48	70	1.46	−2.1	9	6,262	s.	32	n.	28	10	15	5	5.0	0.0	0.0
Grand Haven	632	54	89	29.24	29.91	−.05	61.4	−2.3	85	20	70	45	7	53	28	57	54	77	3.06	+0.6	14	6,232	w.	33	w.	28	13	9	5	5.6	0.0	0.0
Grand Rapids	707	70	87	29.17	29.93	−.04	65.2	−2.9	90	20	75	44	7	55	28	58	54	68	3.18	+0.7	12	3,831	w.	25	w.	6	4	13	13	6.7	0.0	0.0
Houghton	668	62	99	29.19	29.91	−.03	56.6	−3.4	81	22	66	37	8	47	32				1.69	−1.8	11	7,101	w.	39	w.	6	13	10	7	4.8	0.0	0.0
Lansing	878	11	62	28.99	29.92	.....	64.2	−3.2	91	20	75	40	7	53	30	59	55	76	4.94	+1.5	18	2,918	w.	22	nw.	20	6	19	5	5.7	0.0	0.0
Ludington	637	60	66	29.23	29.92	.....	58.4	.....	84	19	67	40	3	50	25	54	50	76	1.14	.....	13	5,572	s.	30	n	29	10	13	7	5.1	0.0	0.0
Marquette	734	77	111	29.14	29.95	+.01	56.0	−2.5	84	22	64	38	8	48	30	50	44	64	1.36	−2.2	13	5,771	nw.	29	sw.	16	8	8	14	5.9	0.0	0.0
Port Huron	638	70	120	29.23	29.92	−.05	62.4	−1.8	91	20	72	41	4	53	30	56	52	71	3.17	−0.1	14	6,227	ne.	42	nw.	20	6	20	4	4.6	0.0	0.0
Saginaw	641	69	77	29.24	29.93	.....	64.2	−2.7	90	20	75	42	9	54	31	57	52	67	1.79	−0.8	8	5,056	sw.	25	sw.	6	4	11	15	6.9	0.0	0.0
Sault St. Marie	614	11	52	29.23	29.92	−.04	56.2	−2.4	79	22	67	37	4	45	34	51	46	69	1.39	−1.4	10	4,828	nw.	35	nw.	6	10	16	4	4.8	0.0	0.0
Chicago	823	140	310	29.06	29.94	−.02	64.5	−3.7	94	19	72	48	8	57	31	57	53	72	6.60	+2.9	17	6,890	n.	38	ne.	8	4	11	15	6.5	0.0	0.0
Green Bay	617	109	144	29.24	29.90	−.05	62.3	−2.8	82	21	71	44	3	54	26	56	52	71	2.74	−0.8	14	6,583	s.	40	ne.	28	4	13	13	6.5	0.0	0.0
Milwaukee	681	125	139	29.20	29.92	−.03	61.2	−2.7	89	19	69	43	7	53	33	56	52	75	4.56	+0.9	12	5,547	ne.	28	ne.	12	4	10	16	6.9	0.0	0.0
Duluth	1,133	11	47	28.71	29.92	−.03	55.9	−1.3	82	22	66	36	7	46	33	51	46	73	3.92	−0.6	14	8,661	ne.	48	nw.	22	4	17	9	6.1	0.0	0.0
North Dakota							**59.9**	**−3.4**										**67**	**5.20**	**+1.5**										**6.1**		
Moorhead	940	50	58	28.89	29.90	.00	61.2	−3.2	84	14	72	35	6	50	34	55	49	66	4.37	+0.2	11	5,294	sw.	29	nw.	5	10	13	7	5.1	0.0	0.0
Bismark	1,674	8	57	28.18	29.94	+.07	60.4	−3.3	84	21	71	42	1	50	36	54	50	71	6.21	+2.7	16	6,064	n.	78	w.	18	3	10	17	7.0	0.0	0.0
Devils Lake	1,478	11	44	28.34	29.90	+.02	59.0	−3.6	83	16	71	33	6	48	34	52	46	65	3.44	−0.1	11	6,492	w.	44	w.	19	12	9	9	5.1	0.0	0.0
Ellendale	1,457	10	56	28.36	29.91	.....	59.7	.....	83	14	71	34	6	49	39				3.74	.....	15	8,165	nw.	44	nw.	5	3	15	12	6.3	0.0	0.0
Grand Forks	835	12	89	.....	.....	.....	60.5	.....	88	16	73	34	6	48	38	54	.....	.....	2.07	.....	11	.....	nw.	36	sw.	20	8	15	7	7.0	0.0	0.0
Williston	1,878	41	48	27.95	29.91	+.05	59.0	−3.7	79	16	69	40	6	49	29	52	46	67	6.78	+3.2	14	5,174	ne.	35	se.	7	6	15	9	5.9	0.0	0.0
Upper Mississippi Valley							**68.6**	**−2.3**										**75**	**6.42**	**+2.1**										**6.2**		
Minneapolis	918	102	206	28.92	29.88	.....	64.6	.....	86	14	74	44	6	55	29	.....	.....	.....	7.35	+3.3	12	7,176	w.	55	w.	19	5	14	11	6.1	0.0	0.0
St. Paul	837	236	261	28.99	29.88	−.04	63.6	−3.5	85	14	73	44	6	54	27	.....	.....	.....	7.24	+2.8	11	7,646	sw.	50	ne.	22	5	21	4	5.1	0.0	0.0
La Crosse	714	11	48	29.13	29.89	−.04	64.4	−3.9	86	19	74	43	1	55	29	.....	.....	.....	6.04	+1.6	15	2,719	w.	19	nw.	30	7	6	17	6.9	0.0	0.0
Madison	974	70	78	28.90	29.93	−.01	63.8	−3.4	86	19	72	45	8	56	23	58	54	74	4.13	0.0	12	4,817	s.	30	ne.	7	4	8	18	7.0	0.0	0.0
Wausau	1,247	4	.....	28.62	29.94	.....	59.0	.....	81	14	69	30	7	49	27	.....	.....	.....	2.41	.....	14	.....	e.	.....	.....	.....	9	5	16	5.9	0.0	0.0
Charles City	1,015	10	49	28.84	29.90	−.01	64.8	−4.0	86	19	75	43	3	55	27	59	55	73	4.04	−1.1	15	4,272	se.	30	se.	28	5	17	8	6.0	0.0	0.0
Davenport	606	71	79	29.25	29.90	−.04	68.0	−2.5	92	19	77	48	3	59	27	62	59	75	9.01	+4.9	17	4,758	e.	30	n.	13	6	11	13	6.6	0.0	0.0
Des Moines	861	84	97	29.00	29.89	−.03	69.0	−1.6	88	13	78	47	6	60	26	63	60	75	9.30	+4.3	14	4,888	se.	45	nw.	28	7	14	9	5.7	0.0	0.0
Dubuque	700	81	96	29.15	29.89	−.04	66.0	−3.4	90	19	74	47	3	58	28	60	56	73	5.37	+0.8	14	3,881	se.	31	n.	2	3	11	16	7.3	0.0	0.0
Keokuk	614	64	78	29.24	29.90	−.04	70.4	−2.1	93	19	79	50	3	62	27	64	60	73	5.94	+1.6	12	4,818	e.	36	nw.	20	6	12	12	6.4	0.0	0.0
Cairo	358	87	93	29.55	29.92	−.05	75.9	−0.4	93	19	84	56	2	68	25	69	67	78	4.78	+0.5	16	5,542	s.	30	n.	17	3	13	14	6.8	0.0	0.0
Peoria	609	11	45	29.27	29.93	−.02	69.2	−1.7	95	19	79	48	6	60	25	63	60	76	8.08	+3.8	15	3,701	se.	48	nw.	28	11	12	7	4.8	0.0	0.0
Springfield, Ill	636	10	91	29.22	29.89	−.06	71.1	−1.1	94	19	80	51	4	62	27	65	62	78	5.47	+1.2	15	5,033	se.	31	nw.	24	5	18	7	5.8	0.0	0.0
Hannibal	534	74	109	29.33	29.89	−.06	71.6	−0.9	93	19	80	51	3	63	25	.....	.....	.....	6.38	+2.9	13	5,405	s.	35	se.	12	6	13	11	5.9	0.0	0.0
St. Louis	568	265	303	29.30	29.90	−.05	73.4	−1.4	93	28	82	54	2	65	23	67	64	75	6.80	+2.3	18	8,307	s.	67	se.—	17	3	12	15	6.5	0.0	0.0
Missouri Valley							**69.0**	**−1.7**										**73**	**5.89**	**+1.6**										**5.3**		
Columbia, Mo	784	11	84	29.06	29.88	−.07	71.8	−1.0	92	19	81	49	2	63	31	.....	.....	.....	7.72	+3.3	17	4,965	se.	48	nw.	24	4	17	9	6.0	0.0	0.0
Kansas City	963	161	181	28.86	29.87	−.05	72.4	−1.2	95	19	81	52	1	63	28	66	63	75	7.87	+3.2	18	7,448	e.	55	n.	26	9	17	4	5.0	0.0	0.0
St. Joseph	967	11	49	28.86	29.87	.....	71.6	.....	91	14	81	50	3	62	30	65	62	75	10.36	.....	20	5,871	se.	57	nw.	12	16	10	4	3.9	0.0	0.0
Springfield, Mo	1,324	98	104	28.53	29.91	−.04	72.4	−0.1	89	28	81	51	2	64	23	67	64	77	7.61	+2.4	12	7,409	s.	43	nw.	15	16	11	3	3.7	0.0	0.0
Iola	984	11	50	28.82	29.84	−.09	75.3	+1.9	95	13	86	50	2	65	30	.....	.....	.....	3.38	−1.4	7	4,819	s.	32	n.	23	11	12	7	4.8	0.0	0.0
Topeka	987	92	107	.....	.....	.....	73.0	−0.4	96	18	83	52	30	63	27	.....	.....	.....	1.97	−2.8	13	7,741	se.	53	n.	22	9	16	5	4.7	0.0	0.0
Drexel	1,299	10	54	28.50	29.87	.....	66.6	.....	88	22	76	44	6	57	27	.....	.....	.....	8.29	.....	21	6,434	se.	46	w.	22	6	16	8	5.7	0.0	0.0
Lincoln	1,189	11	84	28.63	29.87	−.03	69.1	−2.3	91	22	79	48	7	59	30	62	58	72	4.32	0.0	17	6,981	n.	54	nw.	24	8	15	7	5.6	0.0	0.0
Omaha	1,105	115	122	28.73	29.89	−.02	69.0	−2.6	90	22	79	47	7	59	30	63	60	75	9.08	+4.0	16	5,600	se.	52	nw.	24	5	19	6	5.7	0.0	0.0
Valentine	2,598	47	54	27.22	29.89	+.03	64.6	−2.3	89	14	76	44	10	53	40	57	53	69	4.96	+1.2	22	7,497	se.	51	nw.	27	10	15	5	4.8	0.0	0.0
Sioux City	1,135	94	164	28.70	29.90	.00	66.8	−2.7	89	22	76	47	1	57	26	60	56	71	5.42	+1.5	16	7,906	nw.	51	nw.	14	1	20	9	6.2	0.0	0.0
Huron	1,306	59	74	28.54	29.93	+.05	63.6	−2.6	87	22	74	40	6	53	34	58	53	73	7.78	+4.0	17	6,061	se.	62	n.	14	8	16	6	5.4	0.0	0.0
Pierre	1,572	70	75	28.25	29.89	+.02	64.2	−4.3	89	21	74	42	6	54	36	58	54	73	5.19	+2.1	16	6,489	e.	73	nw.	14	5	13	12	6.5	0.0	0.0
Yankton	1,233	49	57	28.59	29.89	.00	65.8	−3.1	91	22	76	45	6	56	31	.....	.....	.....	5.36	+1.1	14	5,169	w.	48	nw.	14	2	20	8	6.0	0.0	0.0

TABLE 1.—*Climatological data for Weather Bureau stations, June, 1924*—Continued

Districts and stations	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. +2 mean min.	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01, or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	*Ft.*	*Ft.*	*In.*	*In.*	*In.*	°F.	°F.	°F.		°F.	°F.		°F.	°F.	°F.	°F.	%	*In.*	*In.*		*Miles*								*0–10*	*In.*	*In.*
Northern Slope							**59.8**	**−1.7**										**61**	**2.05**	**−0.2**										**4.8**		
Billings	3,140	5																													
Havre	2,505	11	44	27.33	29.94	+.09	58.9	−3.1	81	13	71	36	7	47	36	51	46	69	5.76	+2.9	16	4,315	e.	38	w.	15	11	16	3	4.6	0.0	0.0
Helena	4,110	87	112	25.78	29.93	+.05	58.3	−0.9	87	30	71	34	8	46	40	47	39	56	1.14	−1.0	10	5,987	sw.	38	nw.	28	7	17	6	5.4	T.	0.0
Kalispell	2,973	48	56	26.89	29.91	+.02	56.5	−1.2	86	30	69	32	7	44	36	47	39	60	3.24	+1.5	11	4,252	nw.	35	nw.	3	9	15	6	5.0	9.0	0.0
Miles City	2,371	48	55	27.44	29.97	+.12	61.8	−4.2	86	13	72	38	8	52	34	54	48	65	1.72	−1.0	13	4,490	ne.	36	ne.	27	10	10	10	5.2	0.0	0.0
Rapid City	3,259	50	58	26.57	29.93	+.08	62.4	−1.8	89	14	74	38	9	51	37	53	47	60	2.27	−1.3	16	6,197	n.	42	n.	14	4	16	10	5.9	0.0	0.0
Cheyenne	6,088	84	101	24.01	29.86	+.02	60.2	−0.2	88	27	75	35	9	46	39	51	44	59	1.52	0.0	8	8,239	s.	45	sw.	18	10	16	4	4.5	0.0	0.0
Lander	5,372	60	68	24.62	29.87	+.02	60.3	−0.2	88	26	75	33	9	45	42	48	37	48	0.05	−1.1	1	4,121	sw.	32	s.	23	17	12	1	3.6	T.	0.0
Sheridan	3,790	10	47	26.09	29.94		58.2		82	14	71	33	8	46	40	51	46	65	2.01		12	3,776	nw.	35	nw.	27	10	14	6	5.0	0.0	0.0
Yellowstone Park	6,200	11	48	23.88	29.91	+.05	52.6	−3.4	82	30	68	24	8	38	44	42	32	56	0.81	−0.8	7	5,467	sw.	38	s.	6	7	17	6	5.0	1.1	0.0
North Platte	2,821	11	51	27.03	29.91	+.05	67.4	−0.1	93	22	79	41	1	56	40	59	55	70	1.90	−1.4	9	5,474	e.	36	n.	18	15	9	6	4.3	0.0	0.0
Middle Slope							**74.1**	**+2.2**										**58**	**1.24**	**−1.9**										**3.9**		
Denver	5,292	106	113	24.72	29.86	+.02	68.4	+2.1	95	27	82	44	2	55	39	52	40	43	0.46	−1.0	6	5,444	s.	35	sw.	18	14	15	1	3.6	0.0	0.0
Pueblo	4,685	80	86	25.25	29.82	−.01	71.2	+2.2	99	27	87	44	1	56	46	54	41	43	0.34	−1.1	3	5,232	nw.	46	nw.	16	13	17	0	3.5	0.0	0.0
Concordia	1,392	50	58	28.40	29.84	−.06	72.4	−0.6	99	27	83	49	1	61	29	64	59	67	1.87	−3.1	11	5,854	se.	39	ne.	15	7	22	1	4.7	0.0	0.0
Dodge City	2,509	11	51	27.32	29.86	−.07	75.2	+2.7	106	18	89	44	1	61	41	63	57	62	1.23	−2.1	4	6,971	se.	28	ne.	13	20	8	2	3.0	0.0	0.0
Wichita	1,358	139	158	28.42	29.82	−.09	76.9	+2.5	103	27	87	53	1	67	31	67	62	65	0.36	−4.4	5	10,268	s.	52	sw.	24	15	12	3	4.1	0.0	0.0
Broken Arrow	765	11	52	29.04	29.86		78.6		97	13	88	56	2	70	26				2.25		6	10,787	s.	58	s.	8	7	21	2	4.5	0.0	0.0
Muskogee	652	4					79.9		98	13	90	54	23	69	30				5.64		11		e.				9	17	4		0.0	0.0
Oklahoma City	1,214	10	47	28.60	29.84	−.07	80.4	+4.4	102	17	91	55	3	70	29	69	65	67	3.15	+0.1	7	8,366	s.	36	nw.	8	9	19	2	4.1	0.0	0.0
Southern Slope							**81.2**	**+3.7**										**48**	**0.94**	**−1.6**										**2.4**		
Abilene	1,738	10	52	28.09	29.84	−.04	83.3	+5.1	108	15	95	55	3	71	34	69	62	56	0.32	−2.8	2	9,202	s.	38	nw.	2	24	6	0	1.9	0.0	0.0
Amarillo	3,676	10	49	26.22	29.85	.00	78.0	+6.0	106	17	93	46	1	63	39	62	54	54	2.82	−0.2	9	7,424	s.	34	nw.	4	18	12	0	3.5	0.0	0.0
Del Rio	944	64	71	28.90	29.86	+.01	83.8	+0.4	101	16	94	64	2	74	28				0.63	−1.8	1	8,307	se.	40	nw.	1	18	10	2	3.2	0.0	0.0
Roswell	3,566	75	85	26.28	29.78	−.02	79.7	+3.4	106	17	97	51	11	63	51	58	40	34	T.	−1.8	0	6,021	s.	36	w.	21	25	5	0	1.2	0.0	0.0
Southern Plateau							**77.9**	**+3.7**										**26**	**0.07**	**−0.3**										**1.0**		
El Paso	3,762	110	133	26.10	29.73	−.02	84.8	+5.2	106	28	98	60	1	71	38	58	35	21	T.	−0.6	0	7,640	e.	50	ne.	21	29	1	0	1.0	0.0	0.0
Santa Fe	7,013	38	53	23.30	29.77	−.04	68.6	+3.8	92	26	83	38	1	54	37	49	30	29	0.31	−0.7	3	4,756	sw.	32	sw.	7	21	9	0	2.0	0.0	0.0
Flagstaff	6,907	10	59	23.40	29.81	+.03	62.1	+2.8	91	29	81	30	1	43	45	43		30	0.03		1		sw.	36	sw.	17	28	2	0		0.0	0.0
Phoenix	1,108	11	81	28.61	29.72	−.02	87.5	+3.0	112	28	105	60	10	70	43	62	44	27	T.	−0.1	0	4,202	w.	28	se.	29	27	3	0	1.0	0.0	0.0
Yuma	141	9	54	29.60	29.74	.00	88.5	+3.8	113	28	106	62	9	71	42	64	49	31	0.06	+0.1	1	4,165	w.	30	se.	29	30	0	0	0.4	0.0	0.0
Independence	3,957	5	25	25.90	29.84	+.06	76.1	+3.8	101	29	92	46	9	60	45	51	23	16	0.00	−0.1	0	7,284	se.	44	nw.	18	29	1	0	0.6	0.0	0.0
Middle Plateau							**68.3**	**+3.1**										**24**	**0.11**	**−0.4**										**1.9**		
Reno	4,532	74	81	25.44	29.86	.00	65.6	+4.6	100	29	82	39	7	49	45	46	28	30	T.	−0.3	0	6,403	w.	35	sw.	3	26	3	1	1.2	0.0	0.0
Tonopah	6,090	12	20				69.3		94	29	82	38	19	57	36	46	21	16	0.00		0		se								0.0	0.0
Winnemucca	4,344	18	56	25.58	29.90	+.02	64.8	+2.0	103	30	83	30	19	47	49	45	25	27	T.	−0.6	0	5,281	sw.	32	nw.	18	21	6	3	2.2	0.0	0.0
Modena	5,479	10	43	24.59	29.82	.00	65.8	+2.5	100	30	86	33	20	46	49	44	19	22	0.00	−0.4	0	9,291	sw.	50	n.	6	25	5	0	1.4	0.0	0.0
Salt Lake City	4,360	163	203	25.54	29.82	−.03	70.7	+3.3	94	26	82	42	19	59	35	51	32	27	0.56	−0.2	3	5,861	nw.	48	nw.	23	21	9	0	2.1	0.0	0.0
Grand Junction	4,602	60	68	25.32	29.82	−.01	74.4	+3.0	97	27	89	42	8	60	37	51	29	25	0.01	−0.4	1	5,174	se.	38	w.	18	21	8	1	2.8	0.0	0.0
Northern Plateau							**65.4**	**+1.4**										**40**	**0.54**	**−0.6**										**3.8**		
Baker	3,471	48	53	26.42	29.97	+.02	59.5	+0.9	98	30	75	36	6	44	48	47	35	49	0.37	−0.8	5	4,477	nw.	28	nw.	7	16	7	7	4.2	T.	0.0
Boise	2,739	78	86	27.09	29.90	−.01	66.8	+1.5	100	30	82	36	8	52	40	50	34	37	0.51	−0.4	2	3,607	nw.	24	nw.	6	22	6	2	2.4	0.0	0.0
Lewiston	757	40	48	29.12	29.92	−.02	68.8	+2.2	108	30	83	45	6	54	49				0.75	−0.3	6	2,940	e.	21	nw.	3	14	5	11	4.8	0.0	0.0
Pocatello	4,477	60	68	25.42	29.86	−.01	63.8	−0.4	93	30	79	35	9	48	41	46	29	33	0.36	−0.6	2	5,965	sw.	36	sw.	27	19	8	3	3.2	1.0	0.0
Spokane	1,929	101	110	27.90	29.92	−.02	64.4	+1.6	99	30	77	39	7	52	35	50	37	43	0.55	−1.1	4	4,817	sw.	28	sw.	17	10	13	7	5.1	0.0	0.0
Walla Walla	991	57	65	28.87	29.93	−.03	69.2	+2.7	106	30	82	46	7	57	40	53	39	39	0.67	−0.5	5	3,836	sw.	23	w.	6	16	11	3	3.2	0.0	0.0
North Pacific Coast Region							**59.1**	**+0.7**										**70**	**0.75**	**−1.1**										**5.4**		
North Head	211	11	56	29.85	30.08	+.09	53.5	−1.3	77	9	57	44	6	50	26	51	50	90	1.23	−0.5	8	12,207	n.	48	s.	10	3	5	22	8.1	0.0	0.0
Port Angeles	29	8	53		30.08		54.8		79	29	63	42	4	47	31				0.35	−1.0	4	5,330	sw.	30	w.	5	11	11	8		0.0	0.0
Seattle	125	215	250	29.93	30.06	+.06	59.9	+0.9	87	29	68	40	6	51	30	53	47	69	0.35	−1.1	4	5,316	n[1]	28	sw.	10	8	9	13	5.7	0.0	0.0
Tacoma	194	172	201	29.84	30.04	+.01	60.0	+1.3	84	29	69	45	6	51	30				0.51	−1.2	2	5,823	n.	38	sw.	5	5	12	13	6.7	0.0	0.0
Tatoosh Island	86	[2]	57	29.96	30.06	+.04	51.7	−1.3	63	9	55	46	6	48	15	50	49	93	1.58	−2.6	8	6,733	sw.	39	nw.	6	5	10	15	6.8	0.0	0.0
Yakima	1,071	5					66.8		100	30	83	43	6	50	42				0.04		2		nw.				13	10	7	4.5	0.0	0.0
Medford	1,425	4					67.6		106	29	86	39	8	49	53	52	40	49	0.21		4		nw.	16	nw.	21	14	5	11	3.1	0.0	0.0
Portland, Oreg	153	68	106	29.87	30.03	−.01	64.3	+1.9	98	29	75	46	6	54	37	55	49	62	0.68	−1.0	3	4,389	nw.	19	w.	6	10	9	11	5.3	0.0	0.0
Roseburg	510	9	57	29.49	30.03	.00	65.2	+2.7	100	29	80	43	19	50	46	53	44	56	0.56	−0.5	4	2,849	n.	17	sw.	17	14	14	2	3.3	0.0	0.0
Middle Pacific Coast Region							**63.4**	**+0.9**										**62**	**0.01**	**−0.4**										**3.0**		
Eureka	62	73	89	29.99	30.06	+.01	54.1	−0.2	65	14	58	46	7	50	15	51	49	85	0.05	−1.0	1	4,773	n.	35	n.	6	7	17	6	5.3	0.0	0.0
Point Reyes	490	7	18	29.43	29.94		53.0	+0.2	73	20	57	46	1	49	23				0.00		0	13,446	n.w	69	nw.	6	10	4	16	6.3	0.0	0.0
Red Bluff	332	50	56	29.52	29.86	−.02	77.0	+2.2	108	1	92	52	9	62	42	58	42	34	0.00	−0.5	0	4,662	se.	28	n.	6	29	1	0	0.9	0.0	0.0
Sacramento	69	106	117	29.82	29.89	.00	71.0	+1.6	102	29	87	50	10	56	41	57	48	52	0.00	−0.2	0	7,438	s.	27	nw.	19	28	2	0	0.6	0.0	0.0
San Francisco	155	208	243	29.79	29.96	.00	59.8	+1.3	87	20	66	51	6	53	31	53	49	77	0.00	−0.2	0	8,122	w.	36	w.	18	17	7	6	3.8	0.0	0.0
San Jose	141	12	110	29.81	29.96		65.2	+0.2	98	20	80	45	7	50	47				0.00	−0.1	0	5,016	nw.	23	nw.	17	27	1	2	1.4	0.0	0.0
South Pacific Coast Region							**68.5**	**+1.4**										**64**	**T.**	**−0.1**										**2.0**		
Fresno	327	89	98	29.52	29.86	+.01	77.4	+1.6	108	29	94	52	9	61	39	58	41	37	0.00	−0.1	0	6,628	nw.	32	nw.	17	27	3	0	0.8	0.0	0.0
Los Angeles	338	159	191	29.54	29.90	.00	68.2	+1.8	87	20	78	55	10	58	25	58	53	67	0.00	−0.1	0	30,730	sw.	16	sw.	18	21	9	0	2.3	0.0	0.0
San Diego	87	62	70	29.82	29.91	−.01	65.5	+1.6	80	30	71	57	1	60	18	60	58	82	T.	0.0	0	4,723	nw.	28	nw.	29	19	7	4	3.3	0.0	0.0
San Luis Obispo	201	32	40	29.75	29.97	+.02	63.0	+0.8	89	20	76	46	10	50	38	53	48	69	0.00	−0.1	0	3,326	nw.	20	w.	18	25	4	1	1.8	0.0	0.0
West Indies																																
San Juan, P. R.	82	9	54	29.93	30.02		79.0	−0.7	90	17	84	73	21	74	16				5.96	+0.1	21	9,199	e.	38	e.	20	8	15	7	5.2	0.0	0.0
Panama Canal																																
Balboa Heights	118	7	97	29.74	29.86	.00	79.2	−0.8	88	10	85	72	30	74	16	75	74	91	8.41	+1.0	23	4,138	nw.	24	s.	14	0	11	19	8.0	0.0	0.0
Colon	36	7	97	29.83	29.87	.00	80.6	+0.4	90	7	86	74	14	75	15	76	75	90	16.49	+3.1	25	4,334	se.	33	nw.	22	0	7	23	8.4	0.0	0.0
Alaska																																
Juneau	80	11	54	29.97	30.06		55.8		78	11	65	38	5	46	31	50	44	64	0.98		7	4,115	s.	26	nw.	21	10	6	14	5.9	0.0	0.0

TABLE 2.—*Data furnished by the Canadian Meteorological Service, June, 1924*

Stations	Altitude above mean sea level, Jan. 1, 1919	Pressure			Temperature of the air						Precipitation		
		Station reduced to mean of 24 hours	Sea level reduced to mean of 24 hours	Departure from normal	Mean max. + mean min. ÷2	Departure from normal	Mean maximum	Mean minimum	Highest	Lowest	Total	Departure from normal	Total snowfall
	Feet	*In.*	*In.*	*In.*	°*F.*	°*F.*	°*F.*	°*F.*	°*F.*	°*F.*	*In.*	*In.*	*In.*
Father Point, Que	20	29.82	29.84	−.03	50.0	−3.0	58.2	41.9	69	34	2.81	−0.17	0.0
Quebec, Que	296	29.57	29.89	−.03	62.1	+0.9	72.3	52.0	82	41	4.17	+0.52	0.0
Montreal, Que	187	29.67	29.87	−.07	64.1	−0.8	73.8	54.4	82	45	2.00	−1.53	0.0
Ottawa, Ont	236	29.63	29.89	−.05	64.3	−1.0	76.8	51.9	89	39	2.70	−0.22	0.0
Kingston, Ont	285	29.62	29.93	−.04	60.8	−2.6	68.3	53.2	82	40	2.55	+0.12	0.0
Toronto, Ont	379	29.51	29.91	−.06	62.9	−0.5	73.1	52.7	82	39	1.73	−1.07	0.0
Cochrane, Ont	930				54.9		67.1	42.7	77	30	2.42		0.0
White River, Ont	1,244	28.57	29.88	−.06	53.0	−5.7	68.6	37.4	77	27	1.97	−0.25	0.0
Southampton, Ont	656	29.20			58.2	−2.2	67.6	48.8	82	38	3.02	+0.67	0.0
Parry Sound, Ont	688	29.21	29.89	−.07	60.7	−1.0	72.1	49.3	82	37	1.89	−0.53	0.0
Port Arthur, Ont	644	29.20	29.91	−.03	55.8	−0.6	65.8	45.7	80	36	2.51	−0.22	0.0
Minnedosa, Man	1,690	28.10	29.90	+.01	56.0	−3.6	67.9	44.0	80	33	0.85	−2.15	0.0
Le Pas, Man	860				52.0		64.2	39.9	80	28	2.50		0.0
Qu'Appelle, Sask	2,115	27.66	29.89	+.02	55.3	−4.6	67.2	43.4	79	37	2.18	−1.24	0.0
Moose Jaw, Sask	1,759				57.7		70.4	45.1	83	33	1.35		0.0
Swift Current, Sask	2,392	27.37	29.87	.00	58.0	−2.0	70.2	45.8	81	34	2.50	−0.17	0.0
Prince Albert, Sask	1,450	28.39	29.95	+.08	55.4	−2.3	68.2	42.6	81	33	2.00	−0.51	0.0
Battleford, Sask	1,592	28.19	29.92	+.06	57.5	−2.0	72.5	42.6	85	33	0.50	−2.81	0.0
Victoria, B. C	230	29.78	30.03	+.02	56.7	+0.4	64.6	48.9	83	45	0.54	−0.66	0.0

LATE REPORTS FOR MAY, 1924

Sydney, C. B. I	48	29.86	29.91	−.06	47.9	+2.7	58.3	37.6	68	30	3.24	−0.53	0.0
Halifax, N. S	88	29.78	29.89	−.09	50.5	+2.1	59.9	41.1	74	34	2.46	−1.80	0.0
Yarmouth, N. S	65	29.77	29.84	−.14	47.4	−0.2	53.9	41.0	63	32	3.13	−0.67	0.0
Charlottetown, P. E. I	38	29.80	29.84	−.12	48.3	+1.4	56.5	40.0	72	26	0.60	−2.31	0.0
Chatham, N. B	28	29.72	29.75	−.20	47.7	−0.8	58.0	37.5	77	25	3.24	+0.03	0.0
Minnedosa, Man	1,690	28.17	30.01	+.05	44.7	−3.7	57.4	32.1	78	19	0.07	−1.38	0.5
Edmonton, Alb	2,150	27.68	29.95	+.07	52.0	+1.2	67.0	37.0	88	19	1.46	−0.09	T.
Kamloops, B. C	1,262	28.72	29.99	+.10	63.2	+4.1	78.6	47.8	95	35	0.67	−0.57	0.0
Barkerville, B. C	4,180	25.70	30.00	+.16	45.6	+0.1	58.1	33.1	75	24	2.82	+0.30	15.1
Banff, Alb	4,521	25.41	29.96	+.08	48.3	+1.3	64.5	32.0	83	23	1.05	−0.99	0.2
Medicine Hat, Alb	2,144	27.66	29.90	+.01	57.7	+3.6	73.1	42.4	90	32	0.20	−1.11	0.0
Calgary, Alb	3,428	26.45	30.00	+.12	53.5	+4.5	69.2	37.7	89	28	0.89	−0.88	0.0

PUBLICATION OF SEISMOLOGICAL DATA IN THE REVIEW TO BE DISCONTINUED

Announcement is made that a bill (H. R. 8303), quoted hereunder, authorizing the Coast and Geodetic Survey to make seismological investigations and for other purposes, was introduced in the last Congress, passed by the House of Representatives on June 5, 1924, but failed of passage in the Senate because of the legislative congestion in the closing days of the session:

Be it enacted, etc., That the Coast and Geodetic Survey is hereby authorized to make investigations and reports in seismology, including such investigations as have been heretofore performed by the Weather Bureau.

The transfer as above proposed was fully discussed by the two departments concerned, both of which were agreeable to its enactment.

In view of the necessity of effecting economies in the conduct of the work of the Weather Bureau, it has been decided to discontinue, with the close of the fiscal year ending June 30, 1924, the publication of the table of Seismological Reports. The usual table for June, 1924, appears hereunder.—*Editor.*

SEISMOLOGICAL REPORTS FOR JUNE, 1924

W. J. HUMPHREYS, Professor in Charge

[Weather Bureau, Washington, August 3, 1924]

TABLE 1.—*Noninstrumental earthquake reports, June, 1924*

Day	Approximate time, Greenwich civil	Station	Approximate latitude	Approximate longitude	Intensity Rossi-Forel	Number of shocks	Duration	Sounds	Remarks	Observer
		CALIFORNIA								
1924	*H. m.*		° ′	° ′			*M. s.*			
20	4 *ca.*	Eureka	40 48	124 10						U. S. Weather Bureau.
		OKLAHOMA								
3	0 40	Cleveland	36 20	96 25	3	1	30 *ca.*	Rattling	Felt by several	C. C. Breed.
		SOUTH CAROLINA								
3	15 43	Summerville	33 05	80 15	2			Rumbling	do	Mrs. W. Robertson.
		TENNESSEE								
7	5 42	Tiptonville	36 24	89 30	5	1	60	do	Felt by many	Dr. M. R. Donaldson

TABLE 2.—*Instrumental seismological reports, June, 1924*

[Time used: Mean Greenwich, midnight to midnight. Nomenclature: International. For description of stations and instruments see REVIEW for January, 1924]

Date	Character	Phase	Time	Period T	Amplitude AE	Amplitude AN	Distance	Remarks
CALIFORNIA. *Theosophical University, Point Loma*								
1924			*H. m. s.*	*Sec.*	*μ*	*μ*	*Km.*	
June 11			15 00 00		50	50		Tremors during preceding 24 hours.
18					50	50		
30					50	50		
COLORADO. *Regis College, Denver*								
1924			*H. m. s.*	*Sec.*	*μ*	*μ*	*Km.*	
June 26		P_N	2 07 --					P uncertain.
		P_E	2 10 --					
		L	2 33 --	35–40	*2000	*2250		Regular sinusoidal.
		M_N	2 33 --					
		M_E	2 34 --					
		C	2 44 --					
		F	2 56 --					
DISTRICT OF COLUMBIA. *U. S. Weather Bureau, Washington*								
1924			*H. m. s.*	*Sec.*	*μ*	*μ*	*Km.*	
June 4		e	16 15 49					Nothing on EW.
		eL?	16 27 --					
		F	17 *ca.*					
18		P	17 46 11					
		F	17 55 *ca*					
26		P	1 56 53				7400?	Very difficult to interpret.
		PR^1	1 59 55					
		eL	2 18 20					
		L	2 44 30	30				
		L	2 48 --	20				
		L	3 05 --	16				
		F	4 20 *ca*					
30		iP	15 57 00				9,000	
		S	16 07 10					
		L	16 23 50					
		L	16 28 --	28				
		L	16 32 --	16				
		L	16 42 --	18				
		F	17 *ca.*					
ILLINOIS. *U. S. Weather Bureau, Chicago*								
1924			*H. m. s*	*Sec.*	*μ*	*μ*	*Km.*	
June 4		e	3 01 37					
		F	3 15 *ca*					
4		P	16 16 22					
		S	21 05 --					
		L	21 30 --	16				
		F	17 30 *ca*					
14		e	12 28 42					
		S	12 30 03					
		L?	12 30 30	12				
		F	12 50 *ca*					
ILLINOIS. *U. S. Weather Bureau, Chicago*—Continued								
1924			*H. m. s.*	*Sec.*	*μ*	*μ*	*Km.*	
June 18		e?	17 31 53					
		L?	17 42 25					
		F	18 10 *ca*					
22		P	22 36 16				4,000	
		S?	22 42 05					
		L?	22 46 15	16				
		F	23 30 *ca*					
24		e	13 58 33					
		L?	14 07 50					
		F	14 30 *ca*					
26		iP	1 56 56				6,000?	Very difficult to decipher.
		PR^1	1 59 25					
		M	2 45 20		*18,000			
		F	7 *ca*					
30		e	4 25 --					
	•	F	4 40 --					
30		P?	12 15 --					
		F	13 *ca*					
30		P	15 56 22				8,700	
		S	16 06 15					
		SR^1	16 11 35					
		L	16 22 47	30				
		L	16 30 --	22				
		L	16 37 --	18				
		F	20 *ca*					
CANAL ZONE. *Panama Canal, Balboa Heights*								
1924			*H. m. s.*	*Sec.*	*μ*	*μ*	*Miles*	
June 4		P_E	2 45 12				140 *ca.*	Direction SW.
		P_N	2 45 10					
		S_E	2 45 36					
		S_N	2 45 30					
		M_E	2 45 36		*16,000			
		M_N	2 45 30			*11,500		
		F_E	2 52 20					
		F_N	2 53 00					
4								Slight tremor at 3:12:30.
23		P_N	3 30 44				260 *ca.*	Direction unknown.
		P_E	3 30 40					
		S_N	3 31 22					
		S_E	3 31 24					
		M_N	3 34 04			*3,000		
		M_E	3 32 24		*1,800			
		F_N	3 47 00					
		F_E	3 45 12					
26								Slight tremors from distant disturbance from about 2:00 to 3:00.

* Trace amplitude.

TABLE 2.—*Instrumental seismological reports, June, 1924*—Continued

VERMONT. *U. S. Weather Bureau, Northfield*

1924			H. m. s.	Sec.	μ	μ	Km.	
June 26		P	1 57 09					N-S component not in operation.
		L	2 30 17	20				
		L	2 52 --	20				
		L	3 02 --	18				
		F	3 40 --					
30		e	16 06 54					
		F	16 40 *ca*					

CANADA. *Dominion Observatory, Ottawa*

1924			H. m. s.	Sec.	μ	μ	Km.	
June 4		e	3 01 --					
		eL	3 06 --	15				Small.
		F	3 15 --					
4		e_N	16 16 24					After M record quite small, but continues over hour.
		e_E	16 17 56					
		e	16 22 --					
		eL	16 26 --					
		M	16 34 --	15	7	11		
		F	17 40 --					
7		e	19 30 --					
		e	19 35 24					Sinusoidal L waves on NS component.
		eL_E	19 41 --					
		eL_N	19 42 --					
		L_N	19 54 --	15				Small.
		F	20 26 *ca*					
14		$e?_N$	12 31 42					
		e_N	12 33 --					
		M	12 35 12	20	3	6		
		F	12 45 --					
15		eL	11 04 36	12				Very small sinusoidal L waves.
		F	11 18 --					
17		e(S)	21 11 00					
		eL	21 21 --	20	3.5			
		L	21 25 --	20	2.0	2.0		
		F	21 40 --					
18		e?	17 32 --					Two components differ remarkably.
		eL	17 47 18					
		L_E	17 48 --	12	2			
		M_N	17 48 --	20		8		
		M_E	17 52 48	8	4			
		F	18 20 --					
20		e	16 40 42					Sinusoidal L waves.
		eL	16 47 30					
		L	16 51 *to*					
			16 57 --	20				Small.
		F	17 05 --					
22		e?	14 08 --					
		eL	14 13 30					
		L	14 24 30	20				Small; F lost changing sheets.
22		O	22 29 04				4,320	Nothing on vertical.
		P23	22 36 45					
		PR1N	(22 38 18)					
		S	22 42 50					
		SR2N	22 45 51					
		eL	22 49 --					
		L	22 54 --	20	6	3		
		F	23 30 --					
24		$e?_N$	13 58 30					
		e_N	14 00 30					
		e_N	14 03 56					
		eL	14 09 --	30		6		
		M	14 13 --	18	3.6	2.5		
		F	14 44 *ca*					
26		O	(1 44 48)				(9,080)	Difficult to read in terpretation not fully satisfactory.
		iP	1 57 05					
		PR1?	2 00 38					
		PR2?I	(2 02 40)					
		S?	2 07 20					
		i	2 10 40					
		i	2 19 44					
		eL?	2 24 20					
		M17	2 48 38	30	28			
		M23	2 51 --	20		16		
		M17	2 56 --	20	24			
		M	3 05 --	15	6	5		
		M	3 14 --	15	7	4		
		M17	3 21 --	15	4			
		M23	3 23 --	15		4		
		M17	3 38 --	15	3			
		M23	3 40 --	16		2.5		
		LR1-17	4 03 --	60				
		L	4 29 --	60				
		i	4 31 *to*	12				
			5 00 --	19				
		F	7 00 *ca*					

CANADA. *Dominion Observatory, Ottawa*—Continued

1924			HALIFAX RECORD H. m. s.	Sec.	μ	μ	Km.	
June 26		O	(1 45 03)				(9,250)	
		P	1 57 28					
		PR1N	2 01 13					
		S?e	2 07 51					
		i	2 11 04					
		i	2 20 25					
		eL?	2 25 31					
		M	2 57 --					
28		e	23 04 30					Small sinusoidal L waves, more pronounced on No. 17 than on No. 23.
		eL	23 06 --	20				
		L	23 18 --					
		F	23 45 --					
29		e_N	15 27 --					
		eL	15 32 30					
		L_N	15 40 --	20				Small.
		F	16 00 *ca*					
29		e	17 01 --					
		eL	17 08 --	8				Small.
		F	17 22 --					
29		$e?_E$	18 46 30					No time signals.
		$e?_E$	18 50 36					
		eL	18 55 24					
		L	(19 36) --					
		L	(19 47) --					
		L	(20 06) --					
30		F	0 -- --					
30		eL	(4 20) --					Do.
		F	(4 50) --					
30		eL	(12 17) --					Do.
		F	(12 45) --					
30		O	15 44 30				8,780	
		iP	15 56 31					
		iS	16 06 30					
		SR1N	(16 12 08)					
		SR2N	(16 15 53)					
		eL	16 22 --					
		$M1_E$	16 26 --	26	6.5			
		$M1_N$	16 28 --	26		4.5		
		$M2_E$	16 39 --	15	2.5			
		$M2_N$	16 40 --	15		1		
		F	20 *ca* --					

Reports for June, 1924, have not yet been received from the following stations:

ALASKA. *U. S. C. & G. S. Magnetic Observatory*, Sitka.
ARIZONA. *U. S. C. & G. S. Magnetic Observatory*, Tucson.
DISTRICT OF COLUMBIA. *Georgetown University*, Washington,
HAWAII. *U. S. C. & G. S. Magnetic Observatory*, Honolulu.
MARYLAND. *U. S. C. & G. S. Magnetic Observatory*, Cheltenham.
MASSACHUSETTS. *Harvard University*, Cambridge.
MISSOURI. *St. Louis University*, St. Louis.
NEW YORK. *Fordham University*, New York; *Cornell University*, Ithaca.
PORTO RICO. *U. S. C. & G. S. Magnetic Observatory*, Vieques.
CANADA. *Meteorological Service of Canada*, Toronto *and* Victoria.

TABLE 3.—*Late reports (instrumental)*

DISTRICT OF COLUMBIA.—*Georgetown University, Washington*

1924			H. m. s.	Sec.	μ	μ	Km.	
Apr. 13		e	15 11 --					
		L_E	15 38 --					
		L_N	15 40 --					
		F	15 45 --					
13		E_E	14 00 --					Very heavy micros.
		E_N	14 10 --					
		eL?	14 25 48					
		L_E	14 54 21					
		L_N	14 56 34					
		F	15 *ca*.					
14		eP	16 39 47					
		P_NR	16 42 03					
		S_E	16 43 27					
		S_N	16 43 28					
		eL?	16 52 --					
		L_E	17 00 03	38				
		L_N	17 00 14	32				
		F	20 *ca*.					
21		eP_E	20 07 10					Nothing on NS. Micros.
		eS_E	20 12 26					
		eL_E	20 14 24					
		L_E	20 19 15					
		F	21 10 --					

(Plotted by Wilfred P. Day.)

(Plotted by Wilfred P. Day.)

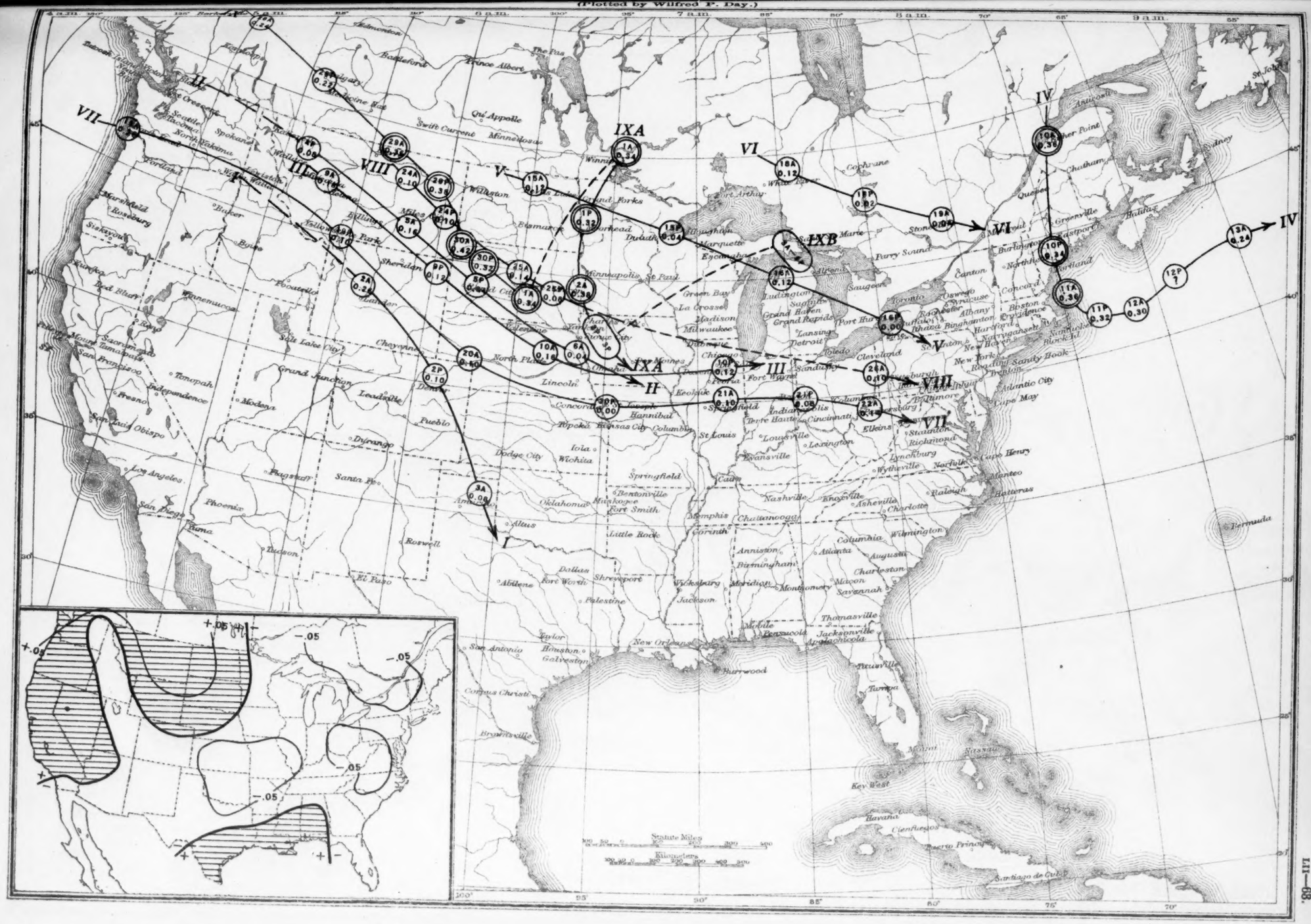


Chart II. Tracks of Centers of Cyclones, June, 1924. (Inset) **Change in Mean Pressure from Preceding Month**

(Plotted by Wilfred P. Day.)

Chart III. Departure (°F.) of the Mean Temperature from the Normal, June, 1924

Chart III. Departure (°F.) of the Mean Temperature from the Normal, June, 1924

Chart IV. Total Precipitation, Inches, June, 1924. (Inset) Departure of Precipitation from Normal

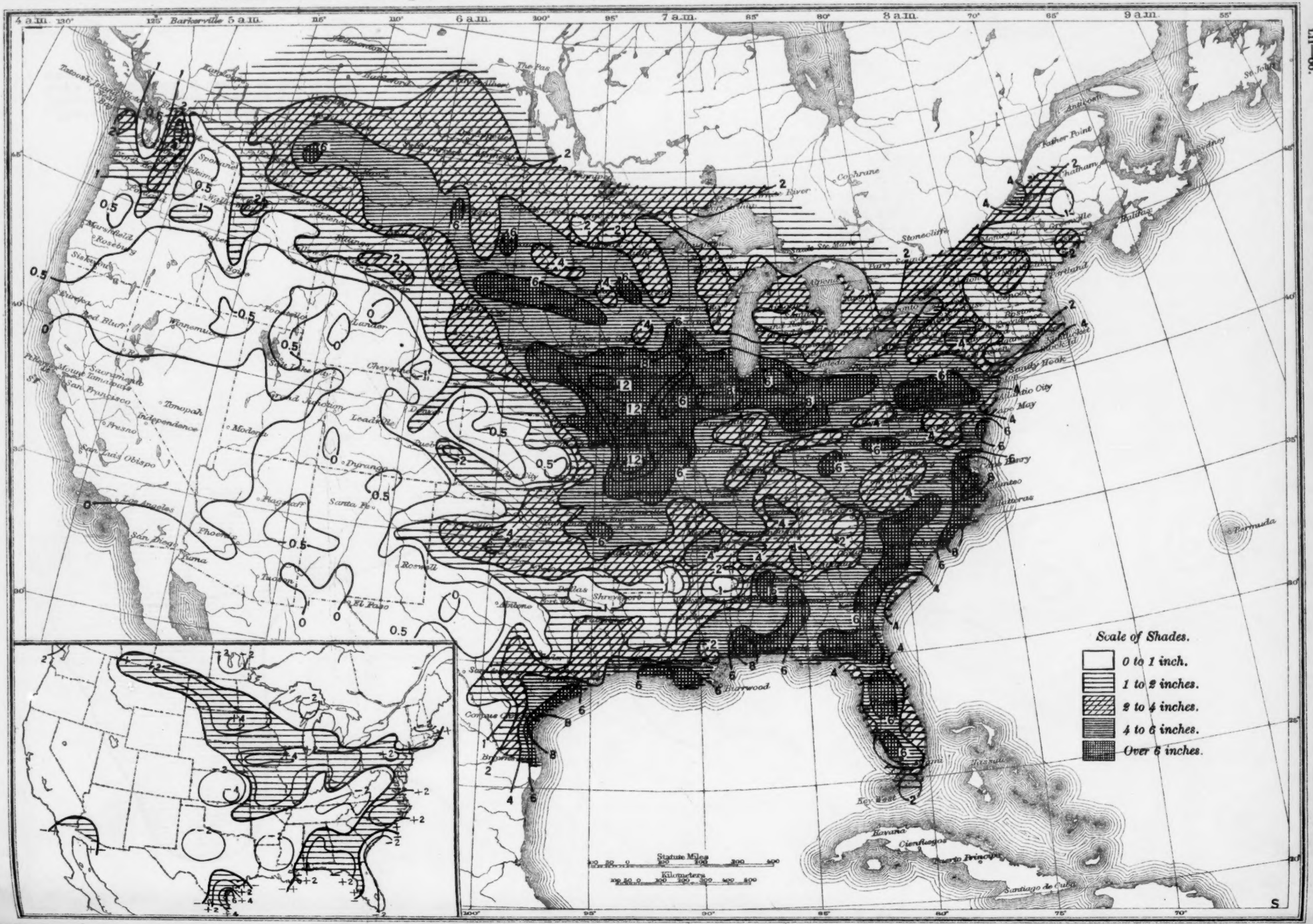


Chart V. Percentage of Clear Sky between Sunrise and Sunset, June, 1924

Chart V. Percentage of Clear Sky between Sunrise and Sunset, June, 1924

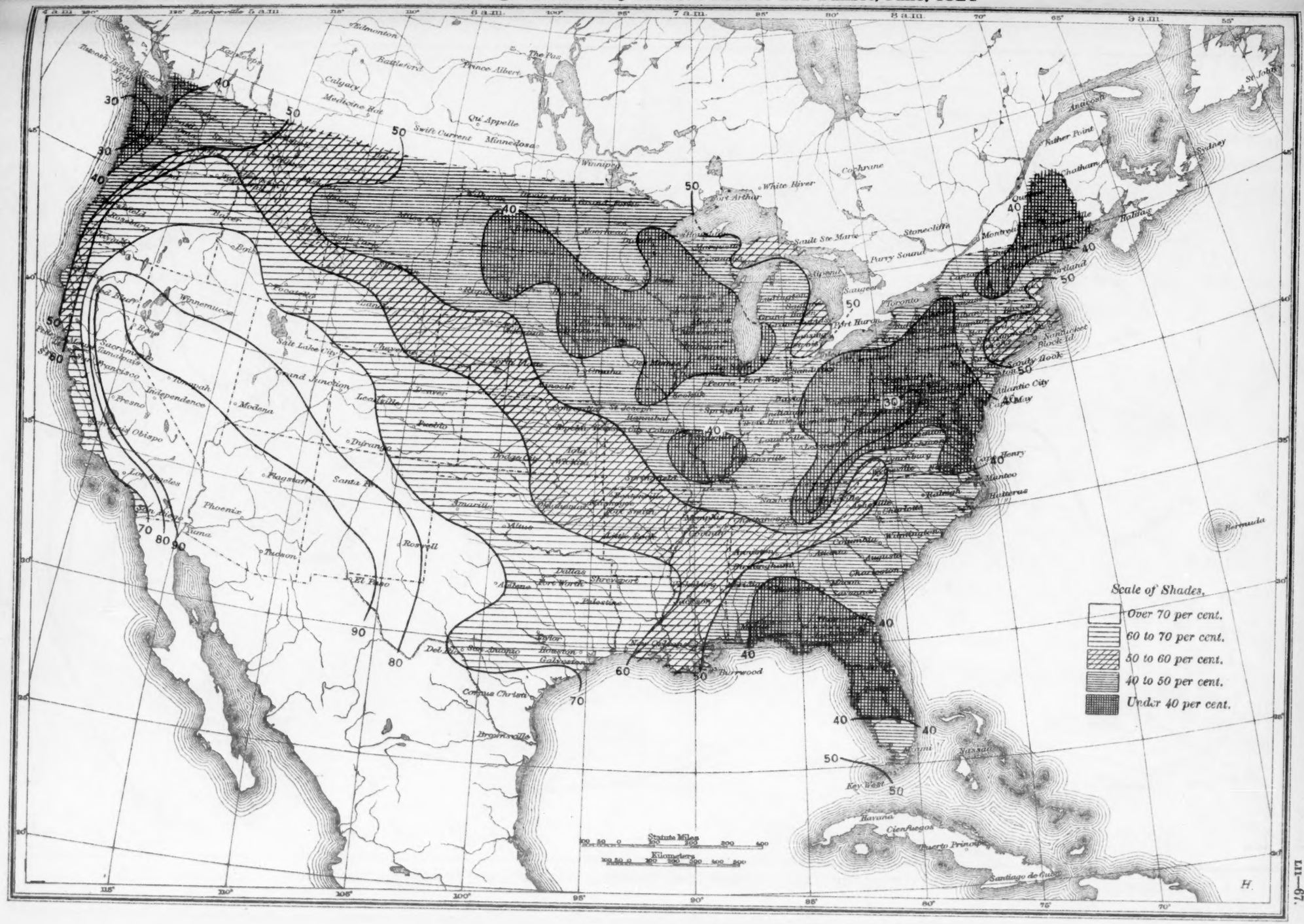


Chart VI. Isobars at Sea level and Isotherms at Surface; Prevailing Winds, June, 1924

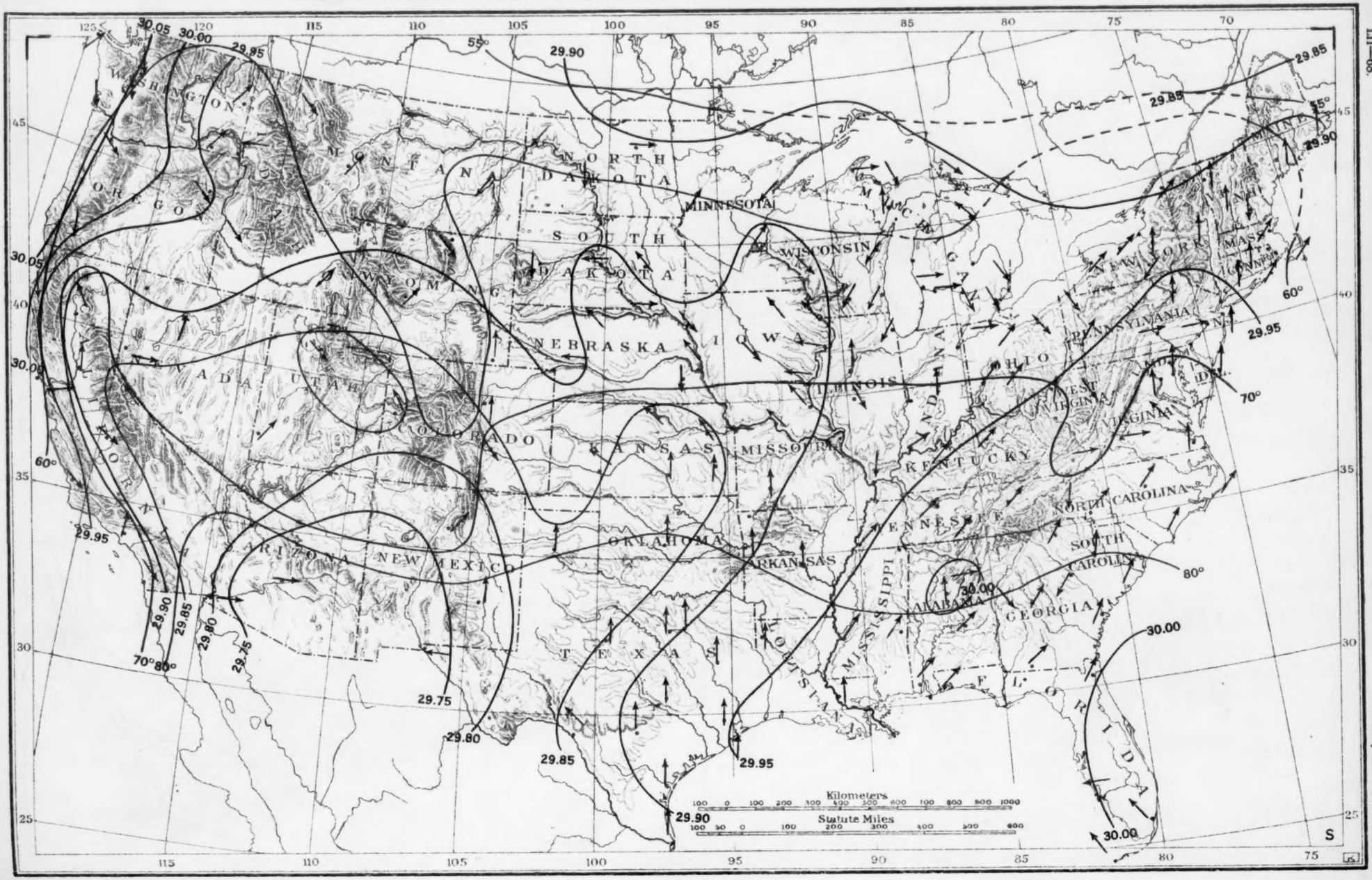


Chart VII. Weather Map of North Atlantic Ocean, June 3, 1924
(Plotted by F. A. Young.)

Chart VIII. Weather Map of North Atlantic Ocean, June 3, 1924

(Plotted by F. A. Young.)

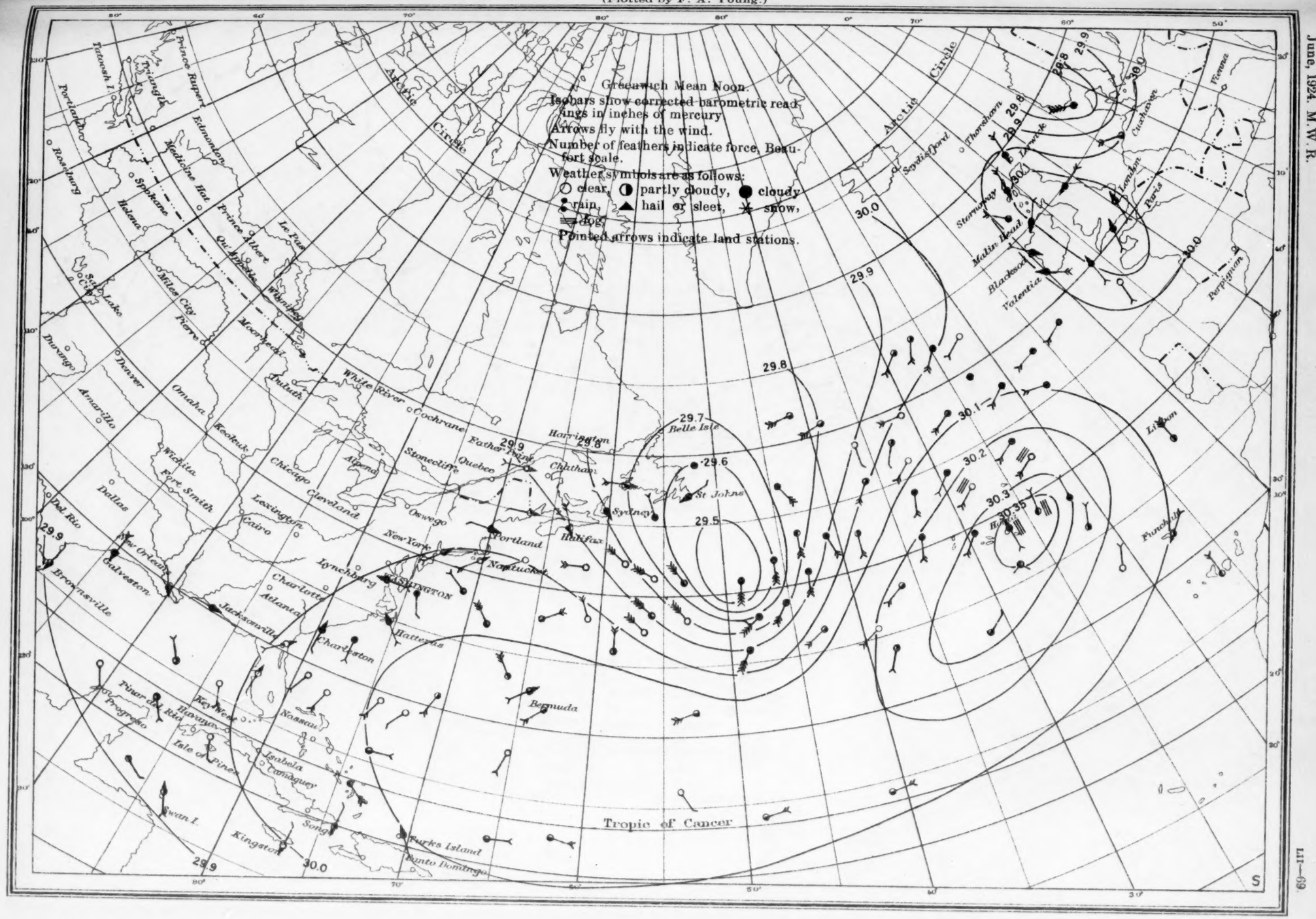
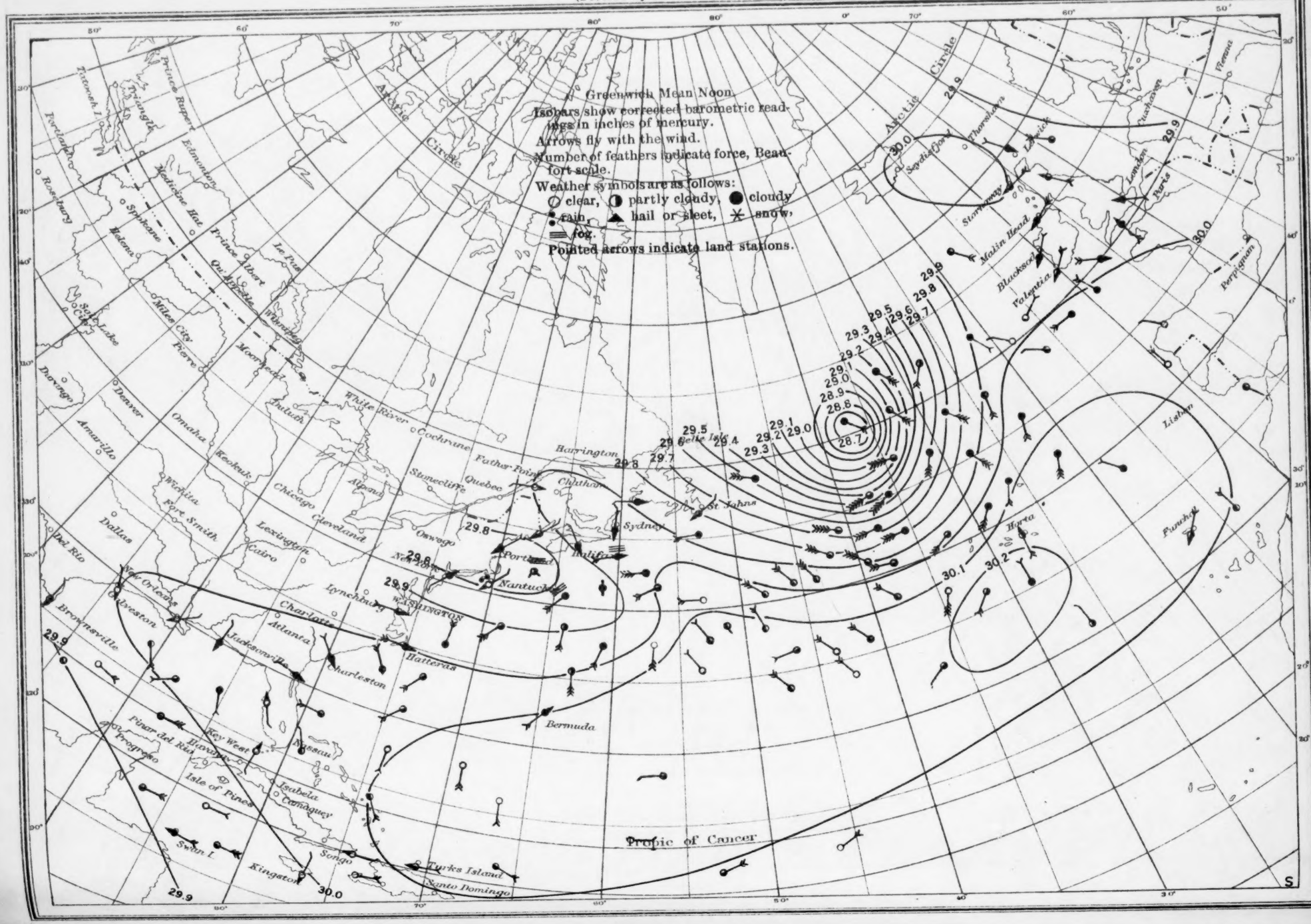


Chart IX. Weather Map of North Atlantic Ocean, June 4, 1924

(Plotted by F. A. Young.)



(Plotted by F. A. Young.)

(Plotted by F. A. Young.)

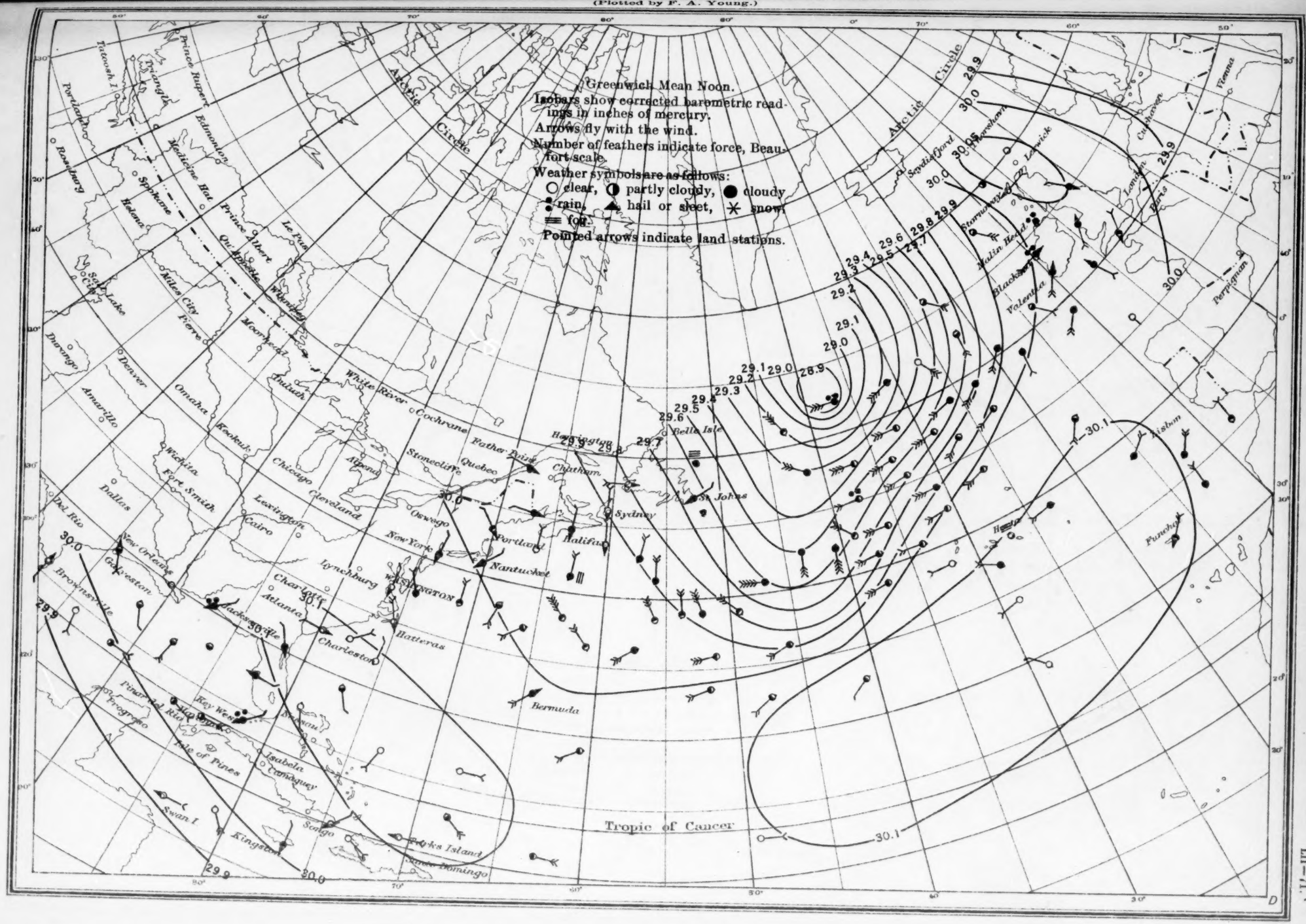
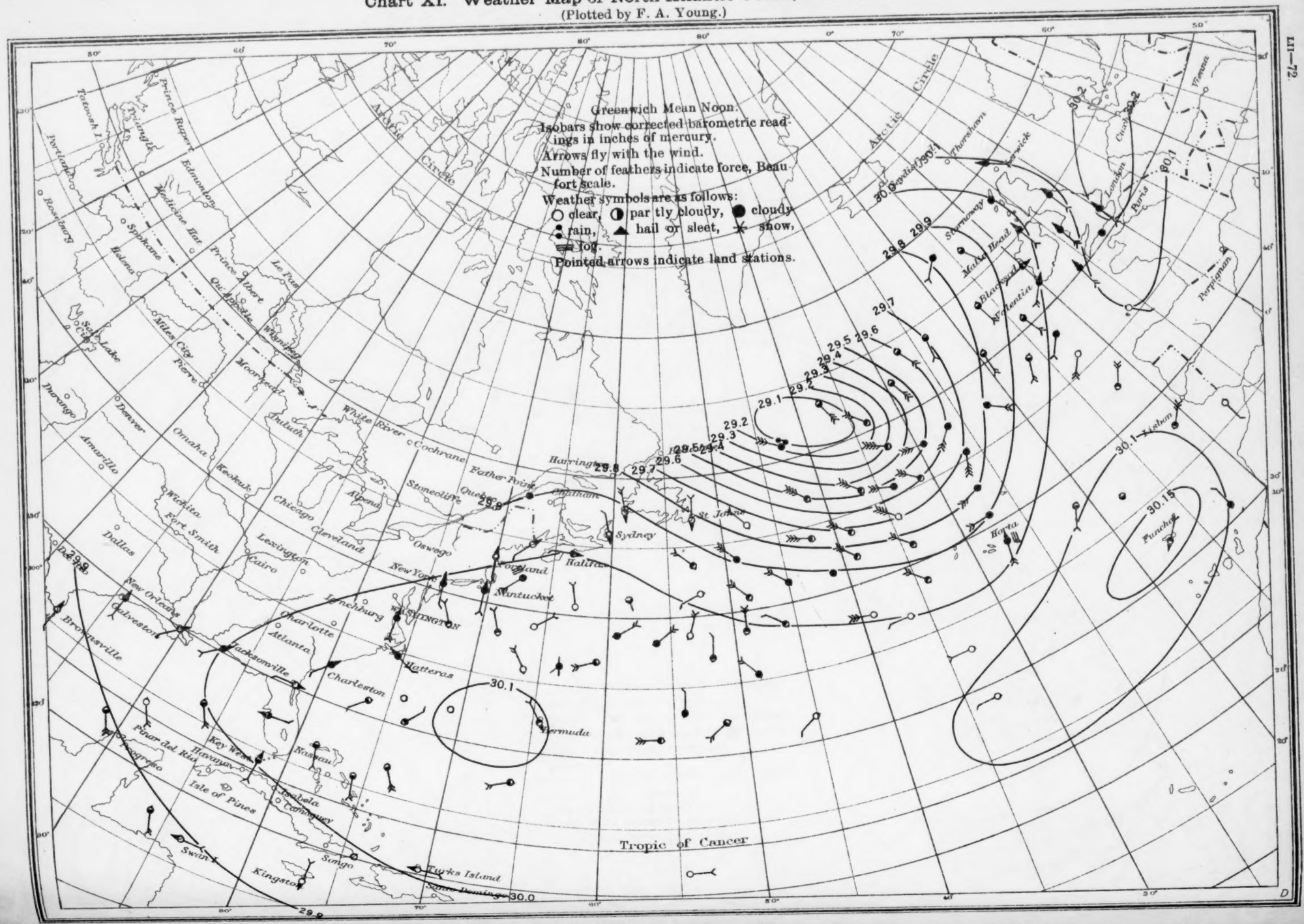


Chart XI. Weather Map of North Atlantic Ocean, June 6, 1924

(Plotted by F. A. Young.)